# Artistic Practices of the Bohol School of Painting: An Analytical and Archival Study of Nineteenth-Century Panel Paintings in the Philippines

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ABSTRACT In the center of the Philippines on the island of Bohol, a unique panel painting practice evolved linking Western artistic methods introduced by the Spanish with Filipino knowledge of materials and techniques. The scientific analysis of five nineteenth-century panel paintings belonging to the Immaculate Conception Parish, Baclayon, was undertaken and combined with an archival investigation of the parish archives to develop a better understanding of their provenance. Results illustrate the construction methods based on Western pictorial techniques used in the panel paintings with an oil medium as well as the utilization of local materials such as Pagsahingin (trade name Kedondong) wood for the panel support, cotton and bast fiber paper for a gap filler between the wood panels, and beeswax for the ground layer. Some of the pigments identified correlate with the geological deposits from the region, and others correspond with the archival church records. Other identified pigments were not referenced in the archives or found locally. The latter indicate the importation of high-quality pigments, not of Filipino origin. Further, the good condition of the panels highlights their sound preparation and an environment suited for these works.

## Introduction

In the Philippines there are numerous nineteenth-century panel paintings by "unknown Bohol masters" (Pilar 2000, 1). Bohol is an island in the Visayas region located in the center of the Philippines, where contact with the Spanish colonists began in 1596 (Jose 2001). The paintings by "Bohol masters" have sound provenance supported by parish archives and local history; five of them are located in the Immaculate Conception Parish of Baclayon in Bohol. According to the parish's Libros de Cargo y Data, 1856–1909 (Book of Income and Accounts, 1856–1909), the paintings were commissioned in 1859 by Father Antonio Ubeda, the parish priest from 1856 to 1859 (Immaculate Conception Parish n.d.).[1] There is little information, however, about the origin of the panel paintings. Recently, Regalado Trota Jose, a well-known historian of colonial church art, proposed that the paintings were either commissioned and transported to Bohol or were painted in Bohol by local artists (personal communication 1998). This paper explores the possible origins of the five paintings using both archival and analytical studies.

Contained in the parish archives are detailed references to art materials and the payment of wages to painters and carpenters, as the Spanish colonists were thorough record keepers and ensured their accounts were well maintained (Jose 1992). These data provided an area of inquiry against which technical examination could be compared in order to determine whether the paintings were painted *in situ*. The five panel paintings in this study are the *Ascension of the Lord* (fig. 1), the *Pentecost*, *San Gregorio Magno*, *San Ambrosio*, and *San Geronimo Maximo*. The first two works are unsigned and the artist is unknown. The latter three

***Figure 1.*** *Artist unknown,* Ascension of the Lord, *ca. 1859. Immaculate Conception Parish, Baclayon, Bohol (This image has been printed with permission from the Roman Catholic Bishop of Tagbilaran.)*

panels are part of a series depicting the four *Augustine Recollect Doctors of the Church* (one of the panels is missing). During recent treatment, the author uncovered an inscription by the artist reading "Liberato Gachalian lo pinto pr. Manda del MRP Antonio Ubeda Año 1859" (Liberato Gachalian painted this as commissioned by Very Reverend Father Antonio Ubeda year 1859).

## General History of the Use of Western Painting Materials in the Philippines and Bohol

The use of Western art materials in the Philippines is well documented. With Spanish colonization in 1521, Western art forms were introduced to help convert Filipinos to the Catholic faith (Santiago 1992). Conversion to Catholicism began in 1596 in Bohol, as Cebu, the main island close to Bohol, was the site of the first Spanish settlement and the capital of the colony from 1565 to 1571 (Jose 2001).

During the early colonial period, artists undertook their training locally in the Philippines (Pilar 1992). For example, as early as 1609, students of the Jesuit school in Loboc in Bohol requested examples of paintings from Santa Maria Maggiore in Rome to copy (Jose 1992). Pilar (1994, 66) states further that Jesuit Father Antonio Sedeno "coached Chinese painters in the early 1580s," and from then on there was a tendency to train *mestiza* artists of mixed Chinese and *indio* or Spanish parentage. The Chinese were assigned the Parian district in Manila, where they set up workshops, and by 1741 they founded their own guild, known as Gremio de Mestizos de Binondo (Guild of Mestizos [mixed Chinese or *indio* and Spanish parentage] from Binondo).

Liberato Gachalian, the artist of three of the panels in this study, is thought to be of Chinese origin according to Pilar, and may even be a descendant of the "Guanyin Master" from Bohol (Pilar 2000, 4). Jose also reports that Gachalian is not a local Visayan name but a Tagalog or Kapampangan name, which is indigenous to the Luzon region where Manila is located (Jose 2001).

## Research Methods

The three areas of inquiry that informed this study included the visual examination of the panel paintings, research in the parish archives, and technical analysis of the panel paintings. The Diocese of Tagbilaran and the Catholic Bishops' Conference Philippines Episcopal Committee for the Cultural Heritage of the Church initiated conservation treatment of the panel paintings. They requested the National Museum of the Philippines, Manila, to undertake treatment, and the author joined the project as a conservator and researcher. A research project was developed jointly by the University of Melbourne Conservation Service, Regalado Trota Jose, and Father Milan Ted Torralba, parochial vicar of the Immaculate Conception Parish of Baclayon.

## Visual Examination

The author conducted two conservation treatment field trips in October and November 1998 in collaboration with the Conservation Department of the National Museum in the Philippines. Preliminary treatment was undertaken when the paintings were still attached to the wall, and hence examination of the reverse was not possible.

### *Archival Research*

Jose collected data from the Libro de Cargo y Data, 1807–1856 and 1856–1909 in the parish archives, Baclayon, and they provided a basis of inquiry for the analysis. Relevant to this study were references to work undertaken by artisans and the purchase and cost of art materials prior to 1859 when the panels were painted (Immaculate Conception Parish n.d.). During the 1850s in Bohol, the monthly wage was two pesos, so the cost of materials sheds some light on their relative value and purpose (Jose personal communication 1998). This study compared the pigments, fillers, papers, and wood recorded in the parish archives with the materials analytically identified.

### *Technical Analysis*

During field visits in 1998, samples were removed from the *Ascension of the Lord*, the *Pentecost*, *San Gregorio Magno*, and *San Geronimo Maximo* for analysis at the University of Melbourne. Technical analysis was not undertaken for *San Ambrosio*; however, similar conclusions were made for this work as it has the same artist, date, provenance, and style as the other two signed works.

#### *Wood Identification*

The Commonwealth Science and Industry Research Organization (CSIRO), Forestry and Wood Division, undertook the wood identification. Thin whittlings from larger splinters were prepared and examined at 50× low-power magnification and 400× high-power magnification.

#### *Pigment and Inert Material Identification*

The pigments were analyzed using a combination of techniques. First, pigment samples were prepared in Meltmount for analysis with polarizing light microscopy (PLM). The slides were viewed under 63× to 400× magnifications. Under plane polarized light and between crossed polars, characteristics as outlined by McCrone (1982) were observed. Second, samples were prepared as cross-sections mounted in polyester resin and examined under reflected and ultraviolet (UV) light for interpretation of the layered structure. Further confirmation of pigments was then undertaken with microchemical tests according to methods outlined by Plesters (1956) and by Hassell and Sheldon (1994).

When identification of pigments was uncertain, Raman spectroscopy and scanning electron microscopy–energy-dispersive spectroscopy (SEM-EDS) were utilized. Raman spectroscopy provided spectra identifiable to the pigment

type, and SEM-EDS provided elemental analysis and images of the surface topography of the paint layers.

*Binder Identification*

First, staining techniques were used to identify the binding media, using a saturated solution of Sudan Black for oil and Amido Black AB3 for proteins (Falcone and Kakoulli 1998). An oil binder was consistently identified in all samples, and to confirm the results, gas chromatography–mass spectroscopy (GC-MS) was undertaken on selected pigmented samples that generally do not interfere with binder identification results (Schilling and Khanjian 1996). Jose also mentioned the use of coconut oil in paint films (Jose 1992), and GC-MS analysis determined whether it was present. The filling material was identified with Fourier transform infrared spectroscopy (FTIR), GC-MS, and a measure of its melting point.

## Results and Discussion

### *Provenance of the Panel Paintings*

Between 7 March and 13 April 1859 the Libro de Cargo y Data records the payment of twenty-four pesos for the paintings of the *Doctors of the Church* series and twenty pesos for the two paintings of the *Ascension of the Lord* and *Saint John the Baptist*.[2] The *Saint John the Baptist* is no longer extant. However, the *Pentecost*, which is in the church has the same dimensions as the *Ascension of the Lord*. The two have identical carved wooden frames with design motifs of pineapples and papayas, and they are companion pieces in terms of their iconography. It can be surmised that these are the paintings to which the parish archives refer. Jose has suggested that *Saint John the Baptist* was painted over with the image of the *Pentecost*, as the archives record the payment of wages to painters (personal communication 1998). Jose has also suggested that Father Ubeda commissioned the five paintings prior to his engagement at the Immaculate Conception Parish, Baclayon, in 1856 and then transported them, since the parish archives detail the crating of items from Cebu in 1858 (Immaculate Conception Parish n.d.; Jose 2003).[3]

## Materials and Techniques

### *Wood Panel Support*

According to Jose (1992), the wood panels were constructed from the hardwood Molave (*Vitex geniculata*) or Narra (*Pterocarpus santalinus/P. pallidus*). Records in the parish archives detail the purchase of Molave reported on December 1857, July to August 1857, May to June 1858, and July to August 1858, and also payments to a teacher of carpentry in December 1857 (Immaculate Conception Parish n.d.). The corresponding expenditure for each record is significant, indicating its relative importance and suggesting the wood may have been used for the wood panel painting support.

Small wood samples from the two panels, *Ascension of the Lord* and *San Geronimo Maximo*, were identified. Thin whittlings were prepared and examined under 10× and 400× magnification. The specimens from both panels were consistent with the wood traded under the name Kedondong (*Canarium asperum* from the Burseraceae family) or Pagsahingin in Tagalog and did not correspond with the woods reported in parish archives as described above (Illic 2003). Interestingly, the Burseraceae family is also the source for Manila elemi (*Canarium luzonicum*), a well-known resin from the Philippines. Its use highlights the technical understanding of wood and its products (Mills and White 1987). Kedondong is a common, semihardwood in the Philippines with poor durability, readily attacked by termites and powder post beetle. Visual examination of the wood panels, however, revealed their stability in spite of the extreme humidity and temperatures on Bohol without any insect damage (fig. 2). The sound condition of the wood panels, despite the known characteristics of the wood, suggests they have been well cared for and housed in a stable environment.[4]

*Wood Panel Construction*

The construction method of the wood panel is based on traditional Western practice; however, the fills between the panels are unique (Veliz 1995). Each panel is 175–320 mm wide, joined with a plain lap join and 30–50 mm wooden pegs across the join. Gaps between the wood are filled with a combination of rolled paper, an unknown brown material,

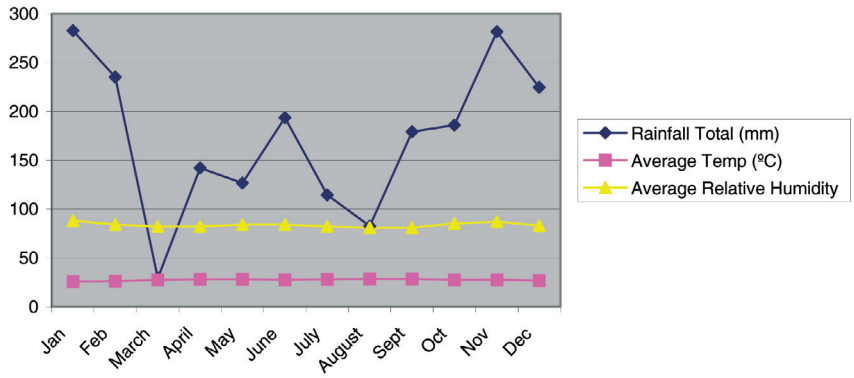


***Figure 2.*** *Climatic data for Tagbilaran City*

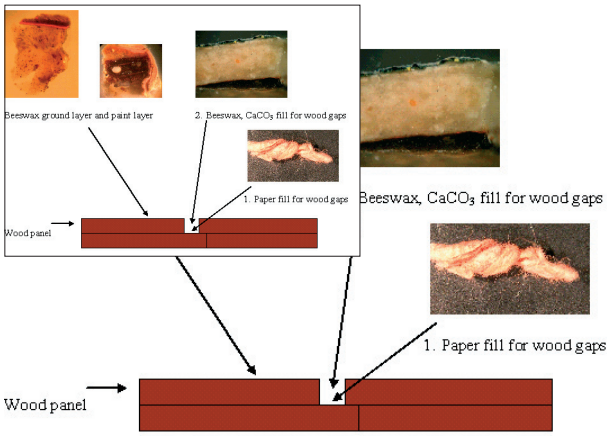


***Figure 3.*** *Diagram of the structure of the five panel paintings examined belonging to the Immaculate Conception Parish, Baclayon, Bohol*

and calcium carbonate (fig. 3). Preliminary examination suggested an old repair. According to Jun Concepcion, paintings conservator, National Museum in the Philippines, however, many panel paintings have been constructed in this way and it is thought to be a standard technique.

*Identification of Wood Gap Filler*

Analysis of the paper in-fill material from the *Ascension of the Lord* and *San Geronimo Maximo* suggested a composite cotton and bast (possibly *k[o]zo* of Japanese practice) and cotton fiber paper, as identified by PLM and Herzberg tests. Examination under magnification and a negative reaction to phloroglucinol suggested the bast or *kōzo* fiber; however, this classification was not conclusive. The fibers themselves are relatively intact, with few interweaving fibrils meshing the paper. The overall construction suggests a handmade paper with a heavy use of size and granular filling material (fig. 4). A positive reaction with the spot test of Amido Black AB3 suggested a gelatin size; however, these tests are indicative and not always reliable.

The surface of the paper is covered with a red chalk or pigment, implying that the paper had been used for another purpose (see fig. 4). PLM identified the pigment as vermilion (HgS), with its high red birefringence under crossed polars.

There are a number of possibilities regarding the source of the vermilion coated paper, identified as a cotton and bast (possibly *kōzo*) fiber paper sized with gelatin. In 1858 the parish archives refer to *cola y papel de Japon* (glue and paper of Japan) (Immaculate Conception Parish n.d.). Today, *papel de Japon* is manufactured locally; however, it is not known when these papers were first manufactured in the Philippines (Jose personal communication 2003). One possibility is that an artistic community of bookbinders and jewelers were producing it under Father Mariano Gutierrez, as recorded in the parish archives in Jagna in 1830, another parish in Bohol. Father Gutierrez taught parishioners how to obtain dyes from local plants, and to make paper and parchment (Jose 2001). Later in the Baclayon parish archives, the purchase of four dozen buttons of vermilion for four pesos was documented in 1858, and this record may relate to the vermilion on the paper (Immaculate Conception Parish n.d.).[5] Alternatively, Jose states that *papel de arroz* from China was mainly used in the Philippines and was composed of bamboo or cotton (Jose 1992). The 1842 commerce records of the Philippines also record the highest number of paper imports from China (Mallat 1994). These Chinese papers may also relate to the composite paper identified. Overall, no positive conclusions can be made for the identification and provenance of the paper.

The brown transparent material used in the gap filler was identified as beeswax and will be discussed in the next section. The white filling material from all the panels was identified as calcium carbonate ($CaCO_3$). Limestone is found naturally throughout the island of Bohol, and calcium carbonate was produced by cooking crushed shells from oysters (Jose 1986). Further, there are references in the archives to the purchase of lime ($CaCO_3$) in December 1857 at the minimal cost of three pesos, implying it was locally obtained (Immaculate Conception Parish n.d.).[6] For the *Ascension of the Lord*, particle sizes varied, and large uncrushed particles revealed a regular structure of biological origin, indicating the calcium carbonate was manually crushed (fig. 5). Its source is likely to be coral stone once known as *piedro de Visayas*, which is formed from a fossil coral reef and accretions of shells (Jose 2003). Another sample from *San Geronimo Maximo* also suggested crushed oyster shells

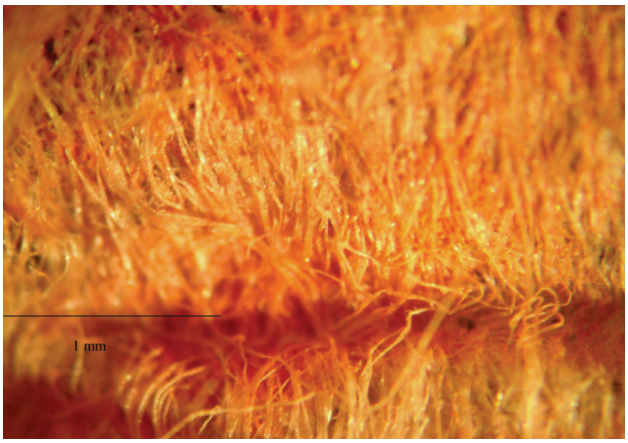


***Figure 4.*** *Photomicrograph of sized rolled paper fill from* Ascension of the Lord *(fig. 1), 63×*

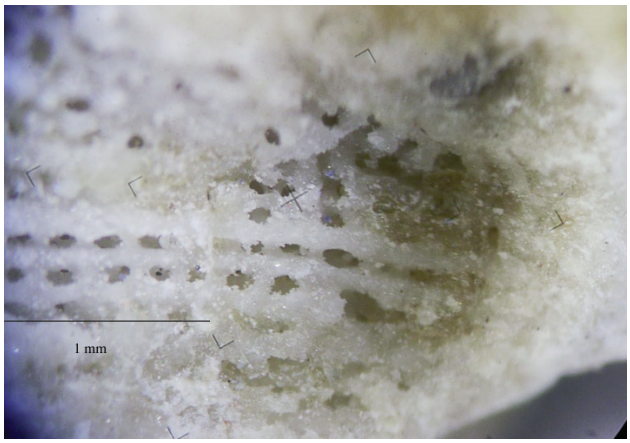


***Figure 5.*** *Photomicrograph of calcium carbonate with a regular structure of biological origin from* Ascension of the Lord *(fig. 1), 63×*

under PLM, as strong cleavage and high birefringence were visible in crossed polars.

*Preparatory Layers*

Cross-section examination of the paint and wood support shows an unusual paint structure (Fig. 6). There is no traditional ground layer directly on the surface of the wood panel even though calcium carbonate was purchased by the parish and used as a wood gap filling material in the panels (Immaculate Conception Paris n.d.).[7] Nor was there confirmation of a proteinaceous size layer with Amido Black AB3 stain for the panels, even though the archives record the purchase of skin and glue (Immaculate Conception Parish n.d.).[8] The cross-sections of the four analyzed paintings reveal a dark brown translucent layer in direct contact with the wood panel followed by the pigmented paint structure; the traditional whiting-based ground layer is lacking (fig. 7). The brown material was soft and flexible, did not fluoresce under UV light, and included a nonmelting black solid (Pellegrino 2003).

Identification of the brown substance was undertaken with FTIR and GC-MS for the *Ascension of the Lord* and *San Geronimo Maximo*. The FTIR spectrum produced the doublet at 2917 $cm^{-1}$ and 2848 $cm^{-1}$, and peaks at 1735.5 $cm^{-1}$ and 1175.92 $cm^{-1}$—results corresponding with the University of Canberra's database spectrum for beeswax. GC-MS analysis produced alternating fatty acid ester peaks with hydrocarbon compound peaks— results also characteristic of beeswax (Mills and White 1987). It appears, then, that beeswax has been used as a preparatory layer on the wood panels and as a bulking material between the wood gaps. This method of preparing a panel for painting has not been reported in translations of treatises on Spanish artistic techniques by F. Numes (*Arts of Poetry, and of Painting and Symmetry, with Principles*, 1615), or by V. Carducho (*The Art of Painting*, 1649) (Veliz 1986). A more typical preparation technique involved the initial application of a layer of size followed by two gesso layers based on plaster of paris. Nor are there references to the purchase of wax in the archives even though "wax, and honey are produced there in great abundance" according to *Conquest of Luzon* (1569–76) (cited in Blair and Robertson 1909, 3:169). It appears that these panel paintings may represent an unusual practice.

*Paint Layer Stratigraphy*

Examination of the cross-sections for the *Ascension of the Lord* and the *Pentecost* shows a beeswax, calcium carbonate, and pigmented paint layer for the wood gaps (fig. 8), and then a beeswax and pigmented layer for the main image (see fig. 6). Generally the paint layers are thin, no greater than six hundred micrometers, and are well bound by the media. The pigments are finely ground and composed of one to two pigment types. Examination of the paint samples in the *Pentecost* indicate there is only one paint layer and it is unlikely that *Saint John the Baptist* was painted over, as proposed by Jose. *The Doctors of the Church—San Gregorio Magno* and *San Geronimo Maximo*—have more complex paint structures and contain beeswax throughout the layers (figs. 9 and 10). Like the other two panels, their preparatory layer is composed of beeswax and not calcium carbonate, as would traditionally have been expected. SEM also identified a well-bound paint layer and cracks resembled slow drying damages rather than hard-edged mechanical cracks (fig. 11). This finding implies that the paint is cohesive and has remained well adhered to both the beeswax preparatory layer and wood panel.

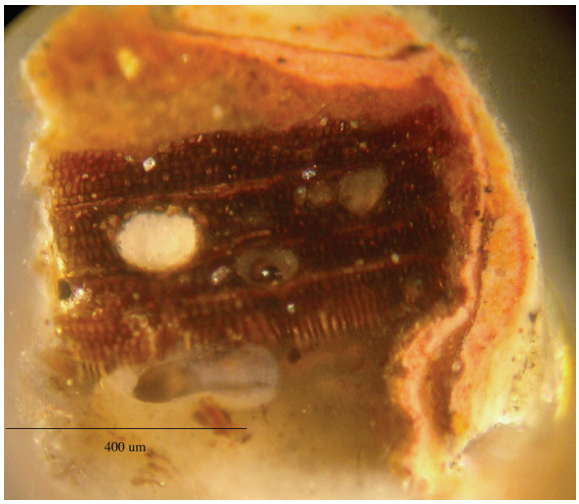


***Figure 6.*** *Photomicrograph of cross-section of Kedondong wood, preparatory layer of beeswax and paint layer from* Ascension of the Lord *(fig. 1), 100×*


***Figure 7.*** *Photomicrograph of beeswax preparatory layer and orpiment from* Ascension of the Lord *(fig. 1), 63×*

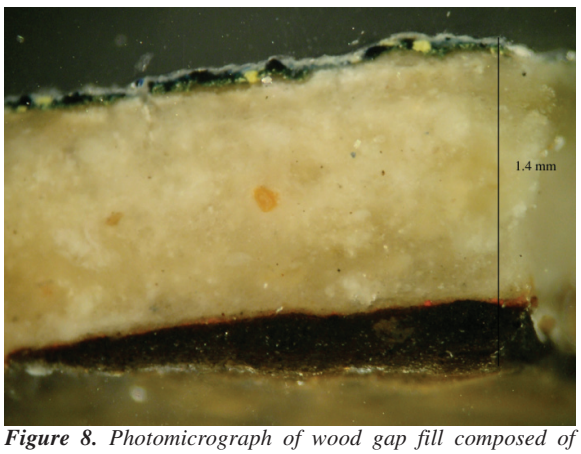


***Figure 8.*** *Photomicrograph of wood gap fill composed of beeswax, calcium carbonate, and a paint layer from Artist unknown,* Pentecost, *ca. 1959, 100×*

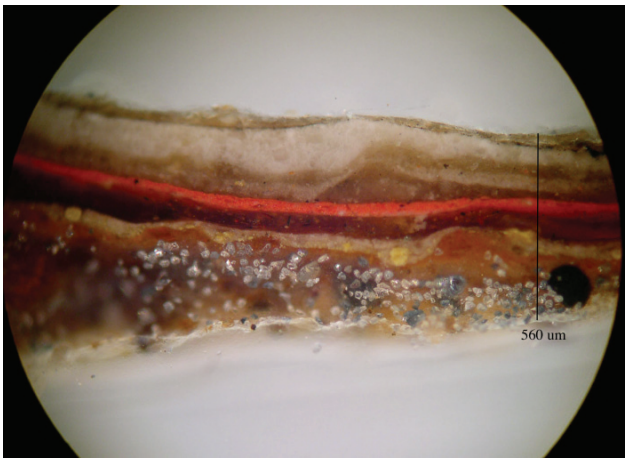


***Figure 9.*** *Photomicrograph of cross-section from Liberato Gachalian,* San Geronimo Maximo*, 1859, 100×*

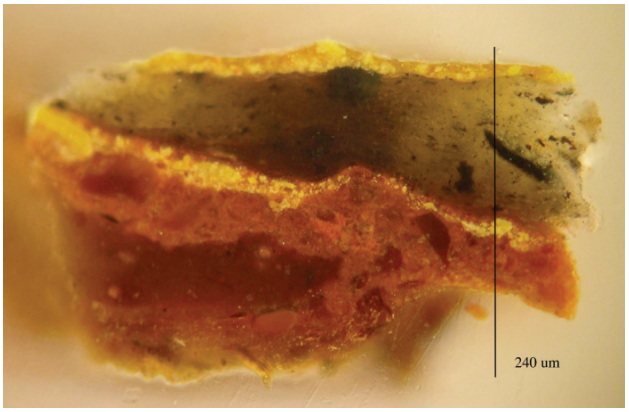


***Figure 10.*** *Photomicrograph of cross-section from Liberato Gachalian,* San Gregorio Magno*, 1859, 100×*

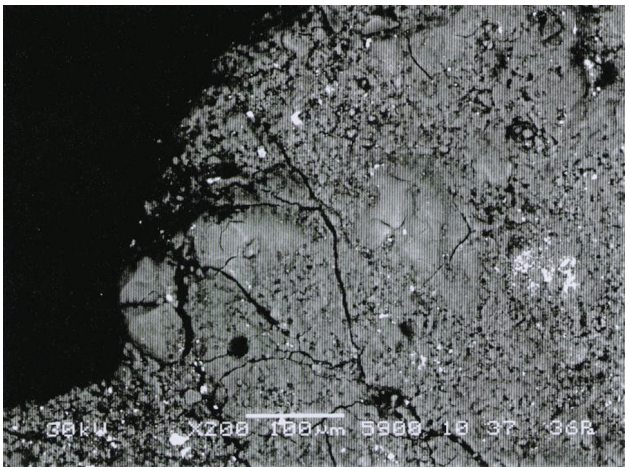

***Figure 11.*** *SEM image of paint surface of* Ascension of the Lord *(fig. 1), 200×*

For all works, UV fluorescence showed no natural resinous inclusions or surface layer. With GC-MS, there was no sign of methyl abietate or methyl dehydroabietate ions, and it is unlikely that resins are present in the paint or applied as a varnish layer. Interestingly, the use of *malapago* varnish for paintings has been recorded by Jose in the Cavite parish archives in the Philippines in 1876 (Jose 2003). *Malapago* is a resin from the Balao tree (*Dipterocarpus gracilis*) from the *Dipterocarpus* spp., where the Gujun balsams originate (Mills and White 1987). They are also part of the Dipterocarpaceae family, the same source for damar resin, which is widely used in traditional Western painting practice.

*Pigments*

Results for the analysis are recorded in table 1 alongside their archival reference. A positive correlation between the archival and analytical results informs the discussion on the possible provenance of the paintings and whether they may have been painted *in situ*.

*Red and White Pigments* The identification of vermilion, red lead, lead white, and calcium carbonate is consistent with the parish archives and coincides with the proposal that the paintings were painted *in situ*. Further, the pigments are finely ground, suggesting they were imported, a suggestion that correlates with their high cost of seventy-five pesos. It was a common European practice to combine vermilion and red lead to lower the cost of producing vermilion pigments (FitzHugh 1985).

*Blue Pigments* The identification of ultramarine (from lapis lazuli) is significant, as it was historically the most expensive and celebrated pigment, reserved for important areas in a painting (Harley 1982). Further, the Spanish record keepers would have undoubtedly recorded it in the parish archives, and this assumption could lead to the conclusion that the *Ascension of the Lord* and *Pentecost* were executed elsewhere and not *in situ*. Jose (2003) has also suggested that the parish may have donated this pigment for use by the local painters, as no blue pigments are recorded in the parish archives. Spanish art treatises (Veliz 1986) refer to smalt and azurite, but test results did not identify these pigments. Indigo is found in the Philippines, but no results confirmed its presence. Finally for the *San Geronimo Maximo* and *San Gregorio Magno*, the blue particles were less consistently identified, and the results are not conclusive.

*Yellow Pigments* The identification of both realgar and orpiment correlates with a Spanish traditional palette for oil painting (Veliz 1986), though there are no references to these pigments in the parish archives. There are, however, records detailing the supply of realgar from Spain from 1569 (cited in Blair and Robertson 1909, 3:245). Gamboge is also not mentioned in the archives, and it is a pigment found mainly in Thailand (Harley 1982). Winter (1987) reports its use in East Asian paintings since the eighth century, and Harley (1982) reports its use as a watercolor paint in Europe from the seventeenth century. In this study, gamboge has been mixed with an oil binder not typical of its usage in Europe. It is not known whether the trees of the genus *Garcinia*, of which gamboge is derived, are found in Bohol, or whether Father Mariano Gutierrez from Jagna Parish was producing this colorant on the island. Its identification, therefore, does not contribute to the panel paintings' history.

*Binders*

Throughout the archives there are a number of entries for *aceite de pintar* (oil of the paintings) (Immaculate Concep-

tion Parish n. d.). Jose's publications further refer to *aceite de linaza* (linseed oil), *aceite de China* (Tung or China oil), and the use of coconut oil in the paint films (Jose 2003, 1992). First, a Sudan Black stain gave a positive result for oil in all cross-sections; however, later GC-MS analysis did not identify any of the above oils according to the palmitic to stearic acid ratios (P/S) (Mills and White 1987). The peaks indicative of the saturated acids in drying oils did give a P/S ratio of 2.457, which corresponds either to pure walnut oil or to a combination of poppy and linseed oil, neither of which is recorded in the archives. Current literature states that it is not possible to differentiate between pure walnut oil and mixtures of linseed and poppy seed oils (Schilling and Khanjian 1996). These oils have traditionally been used in Western pictorial practices, and more specifically walnut oil was the preferred medium of southern Europe (Mills and White 1987). Further, the lack of yellowing in the analyzed paint films indicates walnut oil paint films.

## Conclusions

A comparison of the lists of materials found in the Immaculate Conception Parish Archives, Baclayon, with the findings of the recent visual and technical analysis suggests these materials were not used for the panel paintings. There is some correlation of materials with regards to the identification of vermilion, red lead, lead white, and calcium carbonate, but there are many unrecorded materials identified in the panel paintings. These include natural ultramarine in the *Ascension of the Lord* and *Pentecost*, an expensive and valued pigment; realgar, a pigment used in a typical Spanish palette around this time; gamboge, an organic colorant found in Asia; and Pagsahingin or Kedondong wood instead of Molave. Further, the identified pigments were generally finely ground, indicating they were imported and not obtained locally. Comparative costs for pigments were also high, again indicating that they were mostly imported. This finding is also supported by the archival sources, which document the purchase of the five panel paintings in 1859 and their possible transportation. Overall, the current study cannot contribute more information on the actual origin of the five panel paintings except to state that they were not painted *in situ*.

The study does, however, raise some interesting issues about the materials and techniques of panel paintings during the mid-nineteenth century in Bohol. There appears to be an incorporation of some imported, high-quality pigments with locally ground pigments and the unusual use of beeswax as a primary ground layer in preference to a traditional whiting layer. This combination of a soft beeswax preparatory layer and wood panel may explain the structural stability and sound condition of the panel painting. The fills between the wood are composed of layers of handmade paper with vermilion, beeswax, and calcium carbonate, and this construction is very different from that typical of Spanish panel paintings. The paint media was composed of oil, likely to be walnut, as reported in traditional Spanish practices. The presence of coconut oil was not found, even though Jose mentioned it in the literature. Technical examination also confirmed that there are no changes to the *Pentecost* and it has not been overpainted, even though the archives record a painting with a different title, *Saint John the Baptist*.

## Experimental

### *Materials and Preparation*

Meltmount Material (refractive index of 1.66): Cat. 24160, Cargille Labs, Cedar Grove, N.J. 07009
Saturated Sudan Black in 3:2 ethanol: water (Sigma cat. no. S0395)
Amido Black AB3 (for gelatin id), glycerin, deionized water (Amidoschwartz 10B Merck)
Polyester embedding Resin 480 and MEKP activator from Boatsheath Resin and Service Polyesters

### *Raman spectroscopy*

A Renishaw 2000 Raman Spectroscopy Microscope with a 780nm Diode laser was utilized with a CCD detector for direct 2-D Raman imaging and Raman spectroscopy. Resulting Raman peaks were compared against a known Raman spectroscopic library (Bell et al. 1998). Although excitation wavelengths for this library are 632.8 nm and not 780 nm as for the instrumentation, characteristic peaks were within range and successfully compared.

### *SEM-EDS*

A JEOL JSM-5900 scanning electron microscope with energy-dispersive spectrometer (SEM-EDS unit) was employed, using a backscattered electron (BSE) detector, an x-ray energy-dispersive spectrometer (EDS) and a cathodoluminescence (CL) detector. Samples were simply mounted on a glass slide and imaged at 100× to 800× magnifications.

### *GC-MS*

A Hewlett Packard 5890 gas chromatograph fitted with a Hewlett Packard 5970 mass selective detector was utilized. A Hewlett Packard Ultra 2 column (5% phenyl/95% methyl silicone) was used, and data were processed on a Hewlett Packard G1034C using Chemstation software. Samples analyzed were prepared using Meth-Prep II to produce volatile methyl esters that could be separated during the chromatographic process.

### *FTIR*

A Perkin Elmer FTIR Spectrometer Spectrum 2000 used attenuated total reflection (ATR) with a germanium crystal for the characterization of the beeswax. Examination using

***Table 1.*** *Results of pigment analysis*

| | Colour | Archival reference | Method of detection | Pigment identified | Archival to Analytical |
|---|---|---|---|---|---|
| Unknown Artist *Ascension* circa 1859 | Red | (" 1858 … 10. Oil paint – paint verde, vermilion, red lead, lead white, resin from the Balao tree *(Dipterocarpus gracilis)*, lime. Food for the painters and carpenters all listed in the minutes that were kept.") (" 1857 … Four dozens buttons of vermilion") | PLM: red-orange, circular florets, no pleochroism or cleavage, high relief, RI> 1.66, anisotropic, oblique extinction.<br>SEM EDS: HgMa line, SKa line detected @ 800× | Vermilion (HgS) | Correlates |
| | | | SEM EDS: Pb line, OKa line detected @ 800×<br>Raman: very strong peak 545cm$^{-1}$, weak peaks 387 cm$^{-1}$ and 307 cm$^{-1}$<br>PLM: crossed polars showed green birefringence | Red lead ($Pb_3O_4$) | Correlates |
| | Blue | No record | PLM: isotropic, intense blue pigment, low relief, RI>1.66, no pleochroism or cleavage.<br>Microchemical tests: no Cu or $CaCO_3$, excludes azurite.<br>SEM-EDS: all elemental lines identified for $Na_8(Al_6Si_6O_{24})S_n$<br>Raman: very strong peak 548cm$^{-1}$ | Ultramarine blue ($Na_8(Al_6Si_6O_{24})S_n$)<br>Raman: lapis lazuli | No correlation |
| | | | PLM: possibly cobalt blue, but characteristics not consistent with Becke line behavior. | | No correlation |
| | Yellow | No record | SEM-EDS: AsLa line, SKa line<br>Raman: very strong peak at 351 cm$^{-1}$, strong peak at 306 cm$^{-1}$, medium peak at 287cm$^{-1}$ and weak peak at 378cm$^{-1}$ | Orpiment ($As_2S_3$) | No correlation |
| | | | SEM-EDS: AsLa line, SKa line | Realgar ($As_4S_4$) | No correlation |
| | | | Raman: peaks at 1595 cm$^{-1}$, 1615 cm$^{-1}$, 1463 cm$^{-1}$, 1336 cm$^{-1}$, 1204 cm$^{-1}$, 1189 cm$^{-1}$ and 1163 cm$^{-1}$<br>PLM: regular pebblelike clusters, isotropic, low relief, RI <1.66, no cleavage or pleochroism | Gamboge | No correlation |
| | White | See first record | Micro-chemical tests confirmed Pb, $CaCO_3$PLM: parallel extinction: $CaCO_3$ | Lead white ($2PbCO_3.Pb(OH)_2$) | Correlates |
| | | | PLM and chemical tests | $CaCO_3$ | Correlates |
| Unknown Artist *Pentecost* | Red | See first record | PLM: red-orange, circular florets, no pleochroism or cleavage, high relief, RI> 1.66, anisotropic, oblique extinction.<br>SEM EDS: HgMa line, SKa line detected @ 800×<br>Madder? | Vermilion (HgS) | Correlates |
| | | | Raman: very strong peak 545 cm$^{-1}$, weak peaks 387 cm$^{-1}$ and 307 cm$^{-1}$ | Red lead ($Pb_3O_4$) | Correlates |
| | Blue | No record | PLM: isotropic, intense blue pigment, low relief, RI>1.66, no pleochroism or cleavage.<br>SEM-EDS: all elemental lines identified for $Na_8(Al_6Si_6O_{24})S_n$<br>Raman: very strong peak 548 cm$^{-1}$<br>Chemical tests: no Cu or $CaCO_3$, excludes azurite. | Ultramarine blue ($Na_8(Al_6Si_6O_{24})S_n$)<br>Raman; lapis lazuli | No correlation |
| | Yellow | No record | SEM-EDS: AsLa line, SKa line<br>Raman: very strong peak 351 cm$^{-1}$, strong peak 306 cm$^{-1}$, medium peak 287 cm$^{-1}$ and weak peak 378 cm$^{-1}$ | Orpiment ($As_2S_3$) | No correlation |
| | | | SEM-EDS: AsLa line, SKa line<br>PLM: high relief, opaque, RI>1.6, more indicative of realgar with red-orange particles than orpiment with lemon yellow particles | Realgar ($As_4S_4$) | No correlation |
| | | | Raman: peaks at 1595 cm$^{-1}$, 1615 cm$^{-1}$, 1463 cm$^{-1}$, 1336 cm$^{-1}$, 1204 cm$^{-1}$, 1189 cm$^{-1}$ and 1163 cm$^{-1}$<br>PLM: regular pebblelike clusters, isotropic, low relief, RI <1.66, no cleavage or pleochroism | Gamboge | No correlation |
| | White | See first record | PLM: small rounded particles, RI>1.6<br>Chemical tests: $Pb^{2+}$ with needlelike, yellow particles when exposed to $HNO_3$ and KI | Lead white ($2PbCO_3.Pb(OH)_2$) | Correlates |
| | | | PLM: translucent, low relief, symmetrical extinction, highly birefrigent<br>Chemical tests: effervescence with dilute HCl. | Calcium carbonate | Correlates |

***Table 1.*** *continued*

| | Colour | Archival reference | Method of detection | Pigment identified | Archival to Analytical |
|---|---|---|---|---|---|
| Gachalian, L *San Geronimo Maximo* 1859* | Red | See first record | PLM: red-orange, circular florets, no pleochroism or cleavage, high relief, RI> 1.66, anisotropic, oblique extinction<br>SEM EDS: HgMa line, SKa line detected @ 800× | Vermilion (HgS) | Correlates |
| | | | PLM: showed green birefringence and was deep orange in plane polarized light | Red lead ($Pb_3O_4$) | Correlates |
| | Blue | No record | PLM: smalt but RI does not match, indigo but shape is not needlelike, azurite but pleochroism not visible. | No match | No correlation |
| | White | ("December 1857 … 37 *savanes* ? of lime") Limestone is found naturally in Bohol and produced by cooking crushed oyster shells. | PLM: anisotropic, oblique extinction, high birefringence, high cleavage and elongated shape | Gofun ($CaCO_3$) | Correlates |
| | | | PLM: round florets, parallel extinction<br>Chemical test: $Pb^{2+}$ with needlelike, yellow particles when exposed to $HNO_3$ and KI | Lead white ($2PbCO_3Pb(OH)_2$) | Correlates |
| Gachalian, L *San Gregorio Magno* 1859* | Red | See first record | PLM: red-orange, circular florets, no pleochroism or cleavage, high relief, RI> 1.66, anisotropic, oblique extinction | Vermilion (HgS) | Correlates |
| | | See first record | PLM: showed green birefringence and was deep orange in plane polarized light | Red lead ($Pb_3O_4$) | Correlates |
| | Blue | No record | PLM: smalt but RI does not match, indigo but shape is not needlelike, azurite but pleochroism not visible | No match | No correlation |
| | White | See first record | PLM: translucent, low relief, highly birefrigentChemical microscopy: effervescence with dilute HCl | $CaCO_3$ | Correlates |
| | | | PLM: round florets, parallel extinctionChemical test: $Pb^{2+}$ with needlelike, yellow particles when exposed to $HNO_3$ and KI | Lead white ($2PbCO_3.Pb(OH)_2$) | Correlates |

* no yellow pigments detected and yellow was not visible in the palette

this technique requires that a sample be crushed and rolled onto a potassium bromide plate.

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## Notes

Endnotes quote entries from the Libro de Cargo y Data, 1807–1856 and 1857–1909 held in the parish archives of the Immaculate Conception, Baclayon, Bohol. Listed alongside each record is the expense according to pesos (p)-reales (r)-granos (g).

1. Entry for 13 May 1859:
   *18. Por los 4 Doctores* *24-0-0*
   *19. Por los cuadros de la Ascension del Sr y S Juan en el Bautisterio* *20-0-0*
   In English:
   *18. For the four Doctors.* *24-0-0*
   *19. For two panel paintings of the Ascension and Saint John the Baptist* *20-0-0*
2. See note 1, above.
3. Entry for May and June 1857:
   *8. Por cajones, cargadores, banca y flete a Cebu y de Cebu aqui* *2-3-0*
   In English:
   *8. For the crate, carrier, stand and charter to Cebu and Cebu return.* *2-3-0*
4. Throughout the parish archives are records relating to the repair and care of artworks, including the following:
   Entry for 13 May 1859:
   *21. para dos cuadros de Ascension u S. Juan, mil nipas, coco negros, para continas de las images … de passion*
   In English:
   *21. for the two cuadros of the Ascension and S. Juan, 1000 nipas, coco Negro for the screen of the images of the passion*
5. Entry for July and August 1858:
   *4. 4 docenas de sonboltonios de vermilion* *4-0-0*
   In English:
   *4. Four dozens buttons of vermilion* *4-0-0*
6. Entry for February 1857:
   *4. 37 savanes de cal* *3-4-6*
   In English
   *4. Thirty-seven savanes of lime* *3-4-6*
7. Entry for July and August 1858:
   *15. 21 1/2 ficos de yeso de Dauis y 600 pilonsitas del de China* *27-6-6*
   In English:
   *15. Twenty-one and a half* ficos *of gesso from Dauis and 600 jars from China* *27-6-6*
8. Entry for July and August 1858:
   *16. 6 1/2 ficos de cueros pa cola* *6-6-9*
   In English:
   *16. Six and a half* ficos *of skin and glue* *6-6-9*

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