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Maya Blue is a beautiful blue pigment used by the ancient Maya from the Late Preclassic period (300 BC–AD 300) up into the colonial period.¹ It mimics the color of the azure blue sky and the deep blue of the Caribbean that one sees from the Maya Riviera—that incomparable strip of coastline that stretches along the east side of the Yucatán Peninsula.

Maya Blue was the color of sacrifice for the ancient Maya, and they painted human sacrifices, sculpture, pottery, murals, and codices with it. Symbolizing the rain god Chaak, among other meanings, the Maya employed it largely during the Late Classic, Terminal Classic, and Postclassic. After the Spanish Conquest, it occurred on murals in churches and convents, and there is some evidence that it was used up into the nineteenth century.²

Apart from its incredible blue color, Maya Blue does not fall into a class of just any blue pigment. Rather, it is unique in the ancient world both physically and chemically. Unlike other ancient pigments, Maya Blue is not organic or inorganic. Most pigments usually consist of an organic material derived from a plant, tree, or insect (like cochineal), or are made up of an inorganic mineral (or minerals) such as azurite or lapis lazuli, or are glazes with metallic ions, such as copper, that color them blue or green.

Rather, Maya Blue consists of both an organic component and an inorganic component combined into a single hybrid material. It is a unique human-created combination of an unusual clay mineral called

palygorskite (and/or with sepiolite) and indigo, an ancient dye used throughout Middle and South America before the Spanish Conquest.³ It resists the attack of caustic acids and bases, and its rich blue color does not fade over time, even after exposure for many hundreds of years in one of the world's harshest climates—the tropical forests of southern Mexico and Guatemala.⁴

During the last sixty years, the uniqueness of Maya Blue has simulated great interest among chemists and material scientists who have written many hundreds, if not thousands, of pages to explain its unusual properties trying to discover how the Maya created it. One thing is certain; however, Maya Blue is quite different from either indigo or the clay mineral to which it binds. Now considered the first ever nanostructured artificial organic-inorganic hybrid material, its exceptional stability has inspired much research for designing new such materials. It is one of the world's most unusual pigments.

This stability was dramatically demonstrated by a team from Mexico's Instituto Nacional de Antropología y Historia in 1985. Using a fragment of a blue pigment removed from page 10b of the pre-Hispanic *Códice Maya de México* (formerly the Grolier Codex), the researchers found that it

... resisted the solubility test of six acids, two bleaches, and eight organic solvents, which included hydrochloric acid, nitric acid, aqua regia, sulphuric acid, perchloric acid, acetic acid, acetic hydroxide, sodium dithionite, acetone, methanol, ethanol, xylene, chloroform, carbon tetrachloride, carbon disulfide and benzene, a resistance only observed in the Maya blue pigment.⁵

This unusual characteristic helps drive the continuing study of Maya Blue by chemists and material scientists.

Before the modern rush of tourism forced the closure of many parts of archaeological sites, one could see Maya Blue on the sculpture and murals that still retained its rich blue color, unchanged from the time of its creation. One archaeological site that evinces its persistent color is Chichén Itzá, an ancient Maya city on the northern Yucatán Peninsula. As visitors walk northward from the great Pyramid of Kukulcan to a sinkhole called the "Sacred Well," they encounter a low pyramidal structure known as the Venus Platform. Careful observers will note that the low-relief sculpture on it still retains some of its ancient paint. Looking closely, they can see the remains of a blue pigment clinging to the crumbling limestone, yet with a richness of color unfaded after a millennium of exposure to the harsh tropical sun, torrential downpours, and hurricanes that have plagued Yucatán for centuries. Although much of the pigment has disappeared because of the erosion of the limestone underneath it, that which remains still retains its bright blue color (figure 1.1).



FIGURE 1.1. *Close-up view of Maya Blue on a low-relief sculpture on the Venus Platform at Chichén Itzá, May 2008. Exposed to the weather for at least 900 years, the blue shown here has not lost its color, although the limestone underneath and around it has deteriorated.*

Blue was the color of sacrifice of the Maya, and the most prominent uses of Maya Blue at Chichén Itzá lie hidden within the restricted areas of the site. In the 1960s visitors still had access to some of these areas. One such area was the Temple of the Warriors, where the unique characteristics of the pigment were originally first discovered (figure 1.2). As I strolled among the columns outside of this structure, I could see tiny remnants of Maya Blue on the low-relief figures. In 1970 I was able to enter the chamber under the temple and saw the blue on the headdresses of the figures on the columns (figure 1.3) and the murals on the wall. It was here that chemist H. E. Merwin first noted the unique characteristics of Maya Blue.⁶ Similarly, after the short but steep climb to the Upper Temple of the Jaguar, located on top of the east wall of the ball court, a mural inside the temple also shows the pigment.⁷ All of these areas



FIGURE 1.2. *The Temple of the Warriors at Chichén Itzá. The story of Maya Blue began here when the pigment was first identified on murals and columns in the chamber underneath it.*

are now closed to visitors, but one can still see Maya Blue on the low-relief sculpture in the interior of the Lower Temple of the Jaguar.

It is ironic that although the ancient Maya used Maya Blue widely for more than seventeen centuries, modern scientists still have much to learn about it. Archaeologists, for example, have devoted little attention to the pigment. This book aims to help fill this gap. It documents the story of Maya Blue from its original discovery and summarizes some of the research about its composition, meaning, and creation in a cultural and environmental context. Many others have studied various aspects of the pigment, but this work brings together what I have learned about the pigment: how it was made, how it was used, and how it was spread throughout Mesoamerica from an anthropological and archaeological perspective.

NARRATIVE AND SCIENCE

Like much of science, descriptions of Maya Blue research employ a literary fiction that invokes the passive voice as if the data flowed from the analyses



FIGURE 1.3. *Maya Blue on the headdress of a warrior on a column under the Temple of the Warriors.*

of the pigment through the methodology directly to the written presentation. Such descriptions encourage the illusion that the investigator was merely a passive participant and that the real source of the data was the methodology. Methodology protects the scientific process from methodological biases so that the results measure what they purport to measure and assures that the data can be replicated by another investigator. These procedures thus ensure results that are both valid and reliable.⁸ Nevertheless, the investigator is just as much an instrument of scientific inquiry as physical instruments because personal factors, such as experience and academic training, affect the development of a research design and its execution. Furthermore, inexplicit cultural biases of the investigator can influence the interpretation of the data. As this study will show, these biases also occur in studies of Maya Blue and its constituents.

Consequently, a narrative description of the research design, its development, and its execution provides considerable insight into the scientific process, and thus illuminates a more complete and holistic perspective of Maya Blue than a more impersonal presentation. Why is this? Compared to abstractions derived from scientific observations, “story” is a literary genre that reflects the context of the real world most closely. Since science is concerned with this real world, narratives provide one more way to understand how scientists personally encounter that world. Rather than acquiring knowledge through impersonal methodology, narrative reveals the personal dimension of discovery and adds a more holistic perspective and greater descriptive integrity of the knowing process. When combined with other approaches, narrative provides a powerful way to communicate methodology, data, and the results of one’s research.

Ironically, narrative conforms closely to the manner by which research is reported informally. It is often the way in which scientists interact at professional meetings to exchange ideas, report results, and negotiate books and articles. In fact, it is a common belief, among archaeologists at least, that what happens at parties, book exhibits, bars, and restaurants at professional conferences is just as important as what occurs during the formal presentations in the meeting rooms, if not more so.

Narrative in reporting research thus can restore personal engagement in the scientific process, and it is becoming more appropriate to use “I” and “we” in describing research. Such a change recognizes the agency of human beings in the discovery process rather than the apparent fictional primacy of an impersonal methodology that seems to perform itself. Rather, narrative puts scientific investigation in a larger situated context that shows not just “how” the research was conducted and “what” was accomplished, but also “who” did it, “why,” and under what conditions. It is just as important to focus on the “who,” the “why,” and the context of the research as on just the “what” and the “how.”

Research is thus always situated within a personal, historical, theoretical, cultural, and social context. Understanding this context not only provides a different perspective of the data but helps to clarify why an investigator focused on the topics that he/she did. It provides a larger epistemological context for the methodology and the results. While never substituting for actual data, a narrative approach challenges the sufficiency of the empiricist and logical positivist approaches that dominated science up until the 1960s and complements them. Relating this approach to Maya Blue, the cultural interpretation of the pigment does not follow directly from physical science analyses without knowledge of the cultural context of the investigator as well

as the cultural context in which the data are collected and that of the Maya, both ancient and modern.

So to completely understand the scientific process, one must understand the historical and personal context of the research. This same perspective was laid out by philosopher of science Michael Polanyi,⁹ who recognized that the scientific process of knowing was personally embedded and had a significant personal dimension. Polanyi demonstrated that the discovery of so-called “objective” knowledge in the history of science had ignored the personal dimension of knowing that plays a significant role in scientific discoveries. The investigator and his/her biases (whether explicit or implicit) thus are a significant part of the knowing process that cannot be ignored or neglected but should be made explicit.

Presenting the “knowing process” as a narrative thus reveals a perspective of research consistent with the holistic goals of anthropology itself. Since the anthropologist’s data come from his/her personal experience and is recorded as a narrative in the field, its use in a scholarly presentation provides a holistic perspective of the discovery process. This work thus does not just summarize research about Maya Blue but recounts some of it as “story,” presenting it through a personal perspective of discovery and meaning within the context of Maya culture and the scientific process.

STRUCTURE OF THE BOOK

This book is organized around several themes that correspond to the history, composition, creation, use, and diffusion of the pigment throughout Mesoamerica. The next chapter (chapter 2) documents the history of the discovery of the composition of the pigment. It details what we know about Maya Blue mentioned in the compilation attributed to the sixteenth-century Spanish priest Diego de Landa and summarizes some of the uses and various contexts of what we now know as Maya Blue. Scientists who have studied Maya Blue have emphasized its uniqueness as a hybrid organic-inorganic composite, and chapter 3 surveys the use of some other blue and green pigments throughout the world and compares them with Maya Blue. Chapter 4 describes the chronological journey of my discovery of one of its key components in Yucatán, palygorskite, and its cultural context as a part of Maya Indigenous knowledge. Chapter 5 details the culturally significant sources of palygorskite in modern Yucatán based upon its use for pottery temper and medicinal purposes. It also summarizes data about the antiquity of those sources and why they are part of Maya cultural heritage useful for locating

ancient sources. The following chapter (chapter 6) surveys other sources of palygorskite in the Maya area and evaluates whether the ancient Maya tapped them to produce Maya Blue. Chapter 7 briefly discusses the plant sources of indigo, their distribution, their history in Mesoamerica, and their role in Maya culture. Chapter 8 recounts the process by which the ancient sources of palygorskite used to make Maya Blue were identified by comparing the trace-element analyses of palygorskite from modern sources with those of samples of Maya Blue. These analyses reveal that both Sacalum and a source near Ticul were the actual sources of the mineral used in the Maya Blue on a sample of artifacts from Chichén Itzá and Palenque.

One of the ways in which the ancient Maya created the pigment is explored in chapter 9, showing the role of ritual and how mixing indigo, palygorskite, and copal incense and heating it as an offering to the rain god Chaak gives Maya Blue its sacred status. As convincing as burning copal appears to be in creating the pigment, chapter 10 explores some of the details of the chemistry of making Maya Blue by several other ways in which the ancient Maya might have created it, including grinding a mixture of leaves of the indigo plant (or an aqueous extract from them) and wet palygorskite and then heating it by burning copal or charcoal under it. This chapter also details the evidence of making the pigment in bowls excavated from El Osario (the Grave of the High Priest) by E. H. Thompson in 1896.

The Maya first created Maya Blue in the Late Preclassic period, and chapter 11 explores the ways in which the pigment diffused throughout Mesoamerica. These are grouped into commodity movement (Maya Blue or its constituent, palygorskite) and technology transfer, but in the final analysis both processes were involved in its dissemination. Finally, chapter 12 concludes the book by laying out a few areas of research in anthropology and archaeology that need to be explored in the future.