The University of Pennsylvania Museum of Archaeology and Anthropology Expedition

Lagash Archaeological Project: Preliminary Report on the 2021 Survey Season

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Introduction:

The second season of archaeological research at the site of Tell al-Hiba (ancient Lagash) took place from October 27th through November16 th, 2021. Our research at Lagash for this season consisted on geo-archaeological survey and aerial survey which were initially started at the first field season in 2019. It was important for these two surveys to continue during this season for further exploration of the nature, surrounding environment and resources of the city Lagash. Our research methods comprise geologic coring and drone photography with mapping. In addition to the pre-planned surveys, walking survey was conducted on a low tell to the east of the city.

Geological Coring

Two geoarchaeological sediment cores were extracted for high-resolution analysis of paleoenvironmental signatures related to the archaeological sites of Lagash and Ur (Fig. 1). Core locations were selected to reflect the deep-time ecological context of these ancient cities, their relationship to the ancient Gulf shoreline, and the role of climate change on urban development throughout the region's past. Three methods were employed: rotary drilling, percussion drilling, and hand augering. The Lagash core was sunk to a depth of 11-meters below surface level; in addition, a 1.5-meter section was exposed at the core site to record visible facies and take 2 samples for OSL dating (optically stimulated luminescence). Sediment was recovered as continuous and discrete samples using u-channels and bulk collection in bags, it was characterized by color as well as recorded by depth. The Ur core was sunk to 4 meters below surface level. Recovery and recording methods at Ur repeated those used at Lagash.

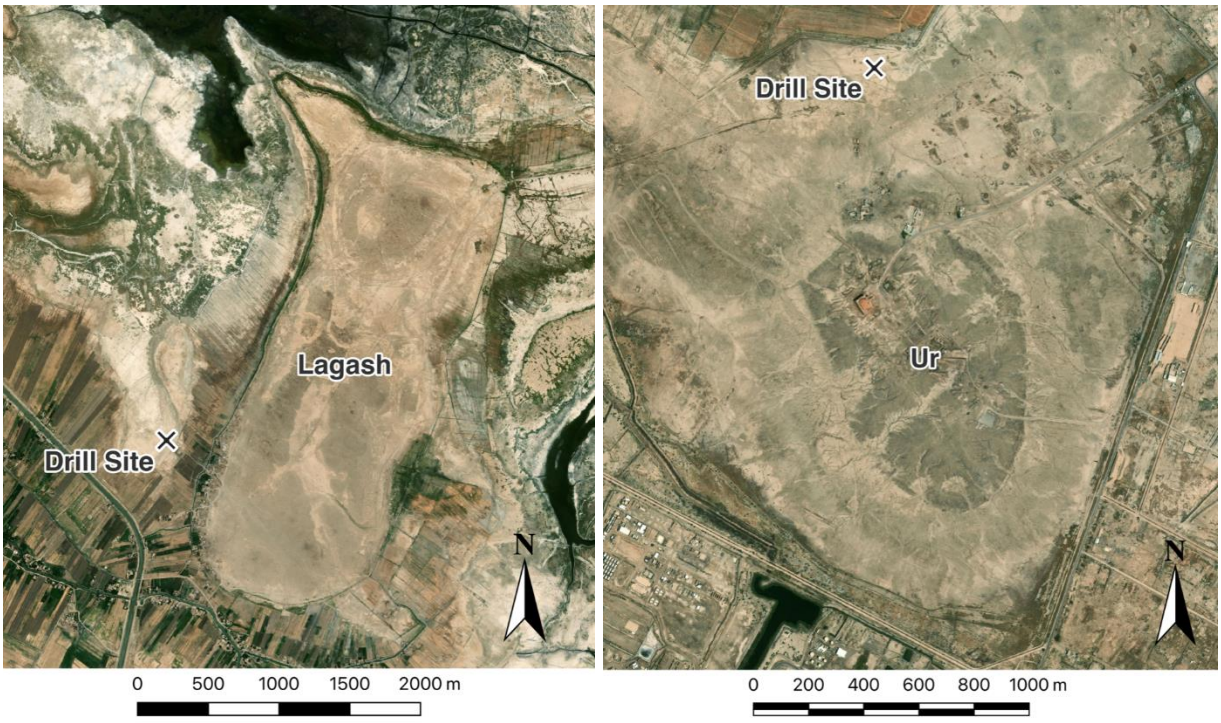

Figure 1: Coring locations.

Sediment samples will be exported to the Woods Hole Oceanographic Institution in Woods Hole, Massachusetts, USA for a range of analyses, including texture, bulk geochemistry through X-Ray fluorescence, isotopic studies, and detrital zircon geochronology to characterize and date the ancient environment, trace river networks (Tigris versus Euphrates), and to interpret these findings against Mesopotamian culture history. Organic inclusions of charcoal and shell will be radiocarbon dated to enable chronological comparison of sedimentary sequences between each core and to interpret these results against previously published geoarchaeological studies in Iraq (Figure 2).

Figure 2: Sectional view of one core sample near Lagash.

Ramped Pyroxidation Pilot Study

We collected bulk sediment samples from known archaeological contexts at the sites of Lagash and Ur for Ramped PyrOx (RPO) just dating. RPO is a new method for dating organic carbon, developed in the geological sciences just several years ago at the National Ocean Sciences Accelerator Mass Spectrometry facility at the Woods Hole Oceanographic Institution. Unlike traditional radiocarbon dating, RPO can identify the amount of contamination in a sample by isolating and measuring the number of different carbon sources present and their relative amounts. It is then possible to determine the historical age of the now uncontaminated sample through radiocarbon analysis. This method has never before been used in archaeology. Absolute dates from historical periods in Mesopotamia remain problematic if not entirely unknown, especially for the earliest periods (5^{th}-, 4^{th}-, and 3rd-millennia BC). To demonstrate RPO's validity, we sampled two archaeological sections of known date at Ur that had previously

been recorded by Sir Leonard Woolley (one from Pit X, one from Pit F) and one section from Lagash (exposed during the 2019 excavation in Area G) (see image of sampled section from pit F, below). If the RPO method produces the expected date range and we therefore prove its efficacy, this method will be widely publicized to the archaeological community within and beyond Iraq. This work therefore has groundbreaking potential for the archaeological sciences.

Figure 3: Sampled section from pit F.

Aerial Photogrammetry

A quad-rotor drone was brought with the LAP 2021 team for aerial photogrammetry. The two main objectives were to complete a photogrammetric topographic survey of the site of Lagash, and to create a 3D photogrammetric model of the E-DUB-LAL-MAH at Ur. Flying the drone and collecting data at Ur were side tasks for the Lagash team to assist Penn Museum's Ur conservation team to continue their work in the near future. Additional side projects were also undertaken whenever possible. The drone used for mapping is a DJI Phantom 4 RTK. When paired with the DJI D-RTK 2 Mobile Station, horizontal positional accuracy of 1.25 cm and vertical accuracy of 2 cm were achieved by combining signals from GPS, GLONASS, Beidu, and Galileo satellite systems. Programming of the flight paths and drone flights were all conducted by Dr. Paul Zimmerman (Figure 4). Processing of the photogrammetric flight data is

being performed with the online service DroneDeploy, but because of slow internet upload speeds only a portion of flight data have yet been turned into maps and models.

Flights in and around Lagash

Lagash Topographic Map

At 500 ha in size, aerial survey of Lagash took five days to complete (November 4th through 8th, 2021). An additional longitudinal (roughly N–S) transect was flown on a sixth day (November 9th) to provide improved vertical control. Over 12,000 photographs were taken at an elevation of 60 m above ground level for the full-site topographic map, and 600 were taken for the transect.

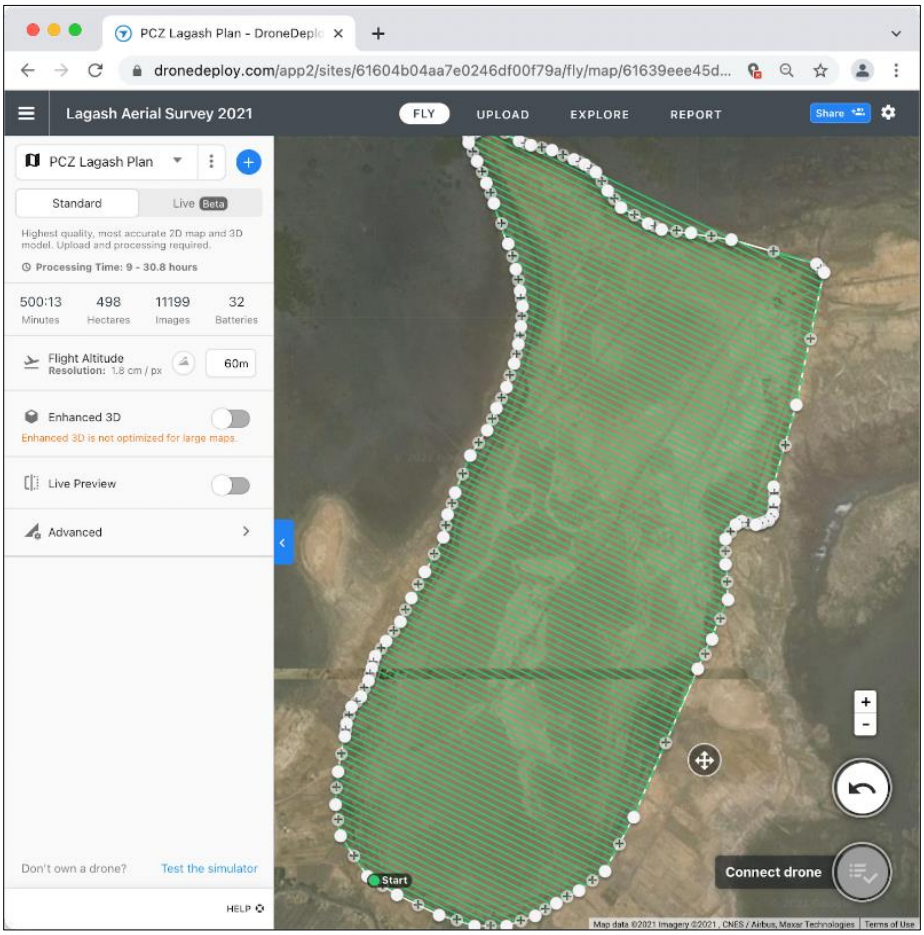

Figure 4: Programed drone flights over Lagash.

Lagash Drill Site Elevation Transect

On November 9th, an E–W transect was flown from west of the Lagash drill site, over the entirety of the tell, and into the plain to its east. This provides the project with a section elevation or interpreting the results of the drilling (Figure 5).

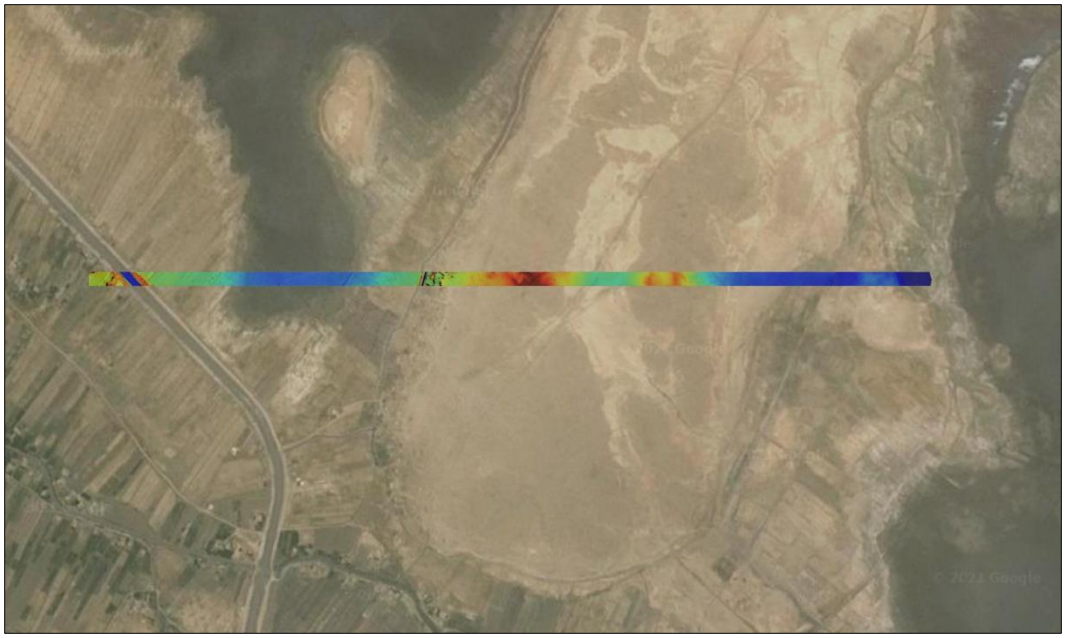

Figure 5: E-W drone flight transect.

Tell al-Abyadh Topographic Map

On November 2nd, over 700 aerial photographs were taken of Tell al-Abyadh, the small site immediately west of Lagash, for the creation of a topographic map (Figure 6).

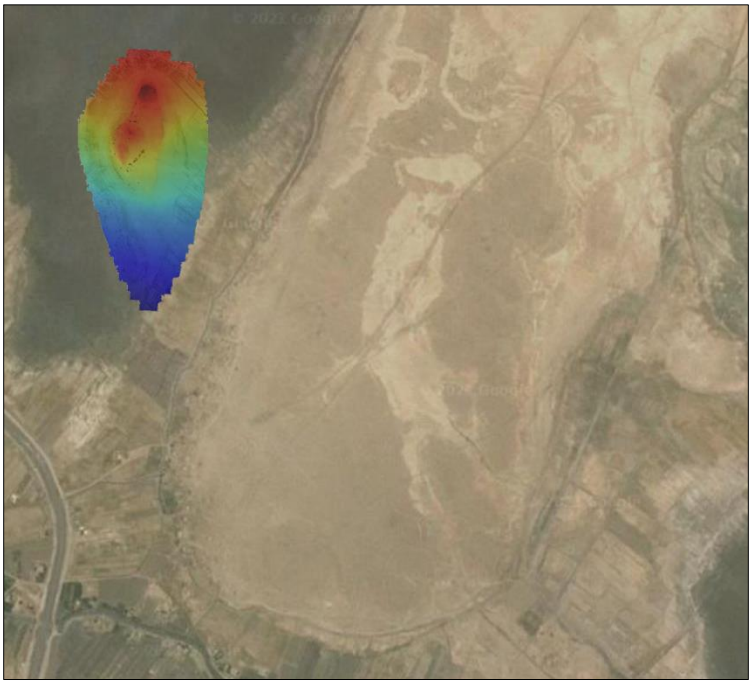

Figure 6: Drone coverage of Tell al-Abayadh.

Flights at Ur

E-DUB-LAL-MAH Model

On November 8th, 200 aerial photographs were taken of the E-DUB-LAL-MAH. These photographs were uploaded to DroneDeploy and successfully turned into a 3D model. Further refinement of the model was attained through additional photographs taken on November 11th (Figure 7).

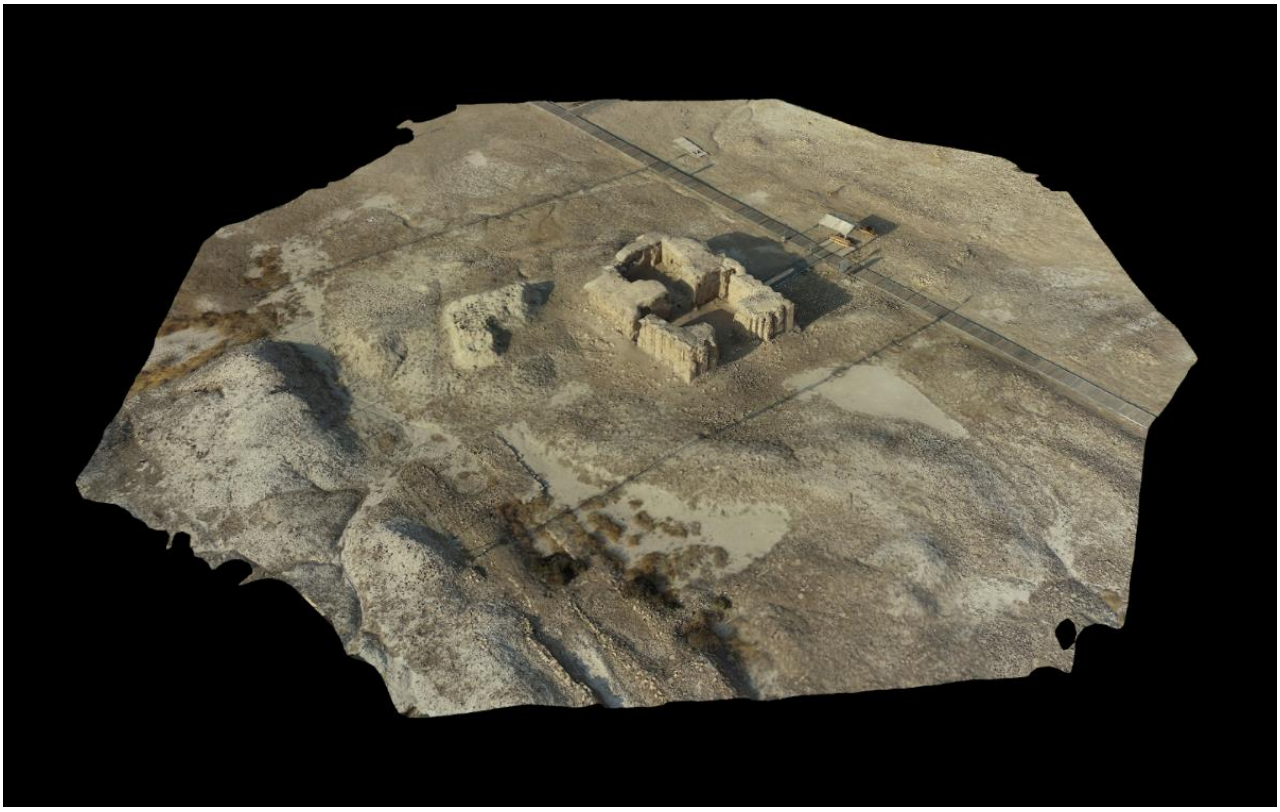

Figure 7: 3D model of the E-DUB-LAL-MAH at Ur.

Ur Ziggurat Model

On November 8th, 890 aerial photographs were taken of the Ziggurat at Ur. These photographs were uploaded to DroneDeploy and successfully turned into a 3D model. Additional photographs of each facade were taken on November 11th to improve the final model (Figure 8).

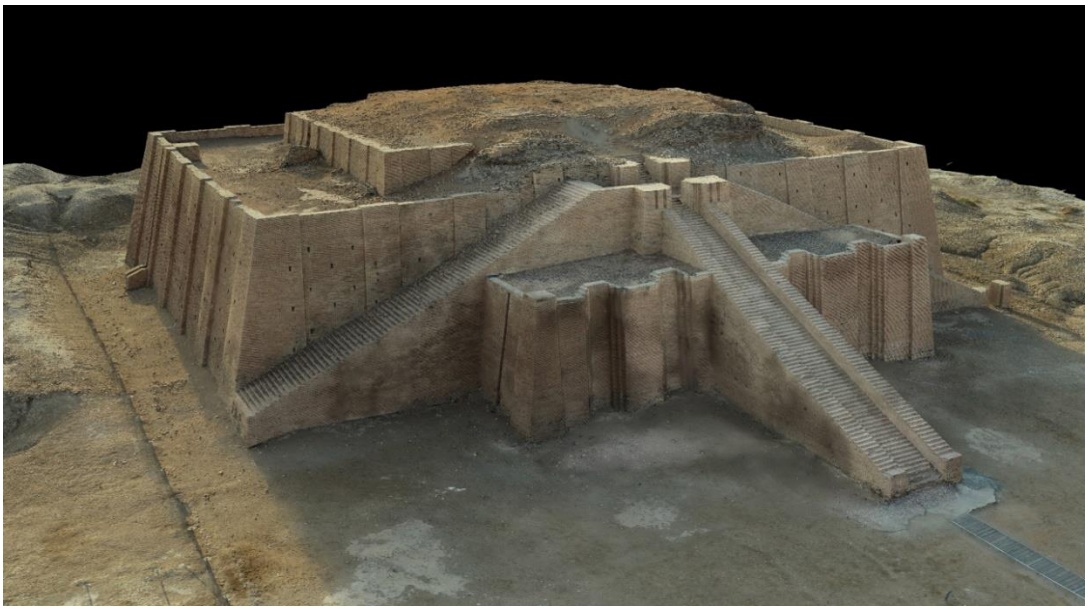

Figure 8: 3D model of the Ziggurat.

Ur Royal Cemetery Topographic Map

On November 8th and November 11th, 890 aerial photographs were taken of the Royal Cemetery of Ur. These photographs were uploaded to DroneDeploy and successfully turned into a 3D model (Figure 9).

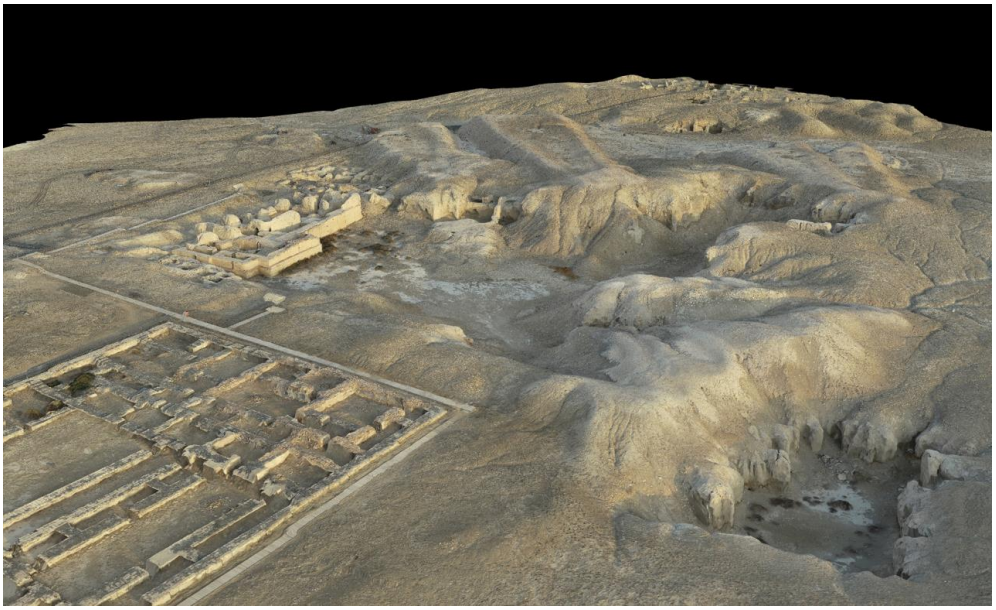

Figure 9: 3D model of the royal cemetery.

Surveying the Eastern Mound from Lagash

Due to shortage of water in the area of Lagash during this season, most of seasonal marshes around the site were completely dry. We took advantage of this environmental condition to broaden our survey work, walking the mounded area to the east of Lagash which was now exposed and previously unexplored (Figure 10). Dr. Zaid Alrawi led a team on to foot to survey this site (Figure 11). The close location of this mounded area and its morphological appearance in the satellite imagery suggests that it is archaeological in nature and belongs to the main mound (Lagash), as is the case with Tell al-Abyadh to the west of Lagash. After extensive observation, the team was unable to detect any archaeological remains on the surface of the tell. It was also noticed that the tell maintains a very low altitude as it rises only about 30-50 cm above the marshy ground surrounding it. It was also observed that the surface of this tell has been used as seasonal grazing ground for buffalos and cattle herders. A suggestion was made for future exploration on this site using GPR or magnetometer devices, which may reveal subsurface remains, as a thick cover of salt may be responsible for its featureless appearance.

Figure 10: Location of the surveyed eastern mound.

Figure 10: Walking survey of the Eastern mound.

Conclusion:

Despite the challenges caused by the CORONA pandemic, which have affected our travel and work plan, the second survey season at Lagash was successful. We continued gathering important information on the ancient environmental context of the city. In addition, we obtained excellent aerial survey data which allow for the creation of topographic maps of the site. Change in the modern environmental conditions (dryness) in the area of Lagash allowed us to reach and explore ground features which were not accessible before.

During our survey work this season, we had the support of Almaaqal University in Basra, represented by its president, Dr. Badr al-Badran, and also by staff members from the engineering department. We also had technical support from staff member Mr. Khalil Alsoudani of Basra University, Geology Department. We are very grateful to them. We hope for more future collaborations with Iraqi colleagues, as the Lagash project develops. We are very grateful to everyone at the State Board of Antiquities and Heritage in Baghdad for their support, especially Dr. Laith Hussain, Mr. Ali Ubaid, Mr. Muhamed Salih, and Mr. Ryadh Hatem. We also thank the staff of the Antiquities Inspectorate of Dhi Qar, especially Mr. Aamir Abdulrazzaq and Mr. Ali Kadum. Our SBAH representatives, Abdulhadi Kready, Firas Abdulnabi, and Baqir Athab, deserve special thanks for their support and energy.