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A Sundial Discovered in Amman Citadel in 2009

Introduction

Amman Citadel has the largest archaeological remains in the core of the city. A sundial was initially discovered by Husam Hejazeen and Yazid Olyan (2005–2007) west of a Roman paved road, running in the ‘bat steps’ style up to the Hercules temple. The Byzantines, who occupied this complex more than 1600 years ago, reused the architectural elements from previous eras but failed to reuse the artifacts containing the sundial, a technological tool used for measuring time. To create the sundial, the artisan used a well-dressed stone, carving an accurate design in both shape and measurements in the Roman-Byzantine style. The sundial has to be situated in an unobstructed place either in a high position or in the center of a complex to observe the time by the position of the shadows formed on the sundial by the vane. In a complete sundial, the bronze vane is fixed in the center of the hemispherical stone in the upper horizontal

position, but unfortunately in this sundial, just the fixed part of the metal rod is still preserved in the dressed stone. It was the work of a professional engineer and/or astronomer to incise accurate lines on the base to be able to measure time. This study will focus on the discovery of the sundial and the scientific ways of using rays from the sun for measuring time.

The ability to tell time has long been necessary for agricultural production. From the Paleolithic and Neolithic periods, human beings discovered that to grow plants and cereals special seasons were needed. To take advantage of the seasons you needed to measure time. Jumping forward in time, monasteries were usually built in rural areas to support the monks in their lifestyle and in meditation. Their activities and ceremonies usually took place outside, allowing them to observe the movement of the sun, moon, and stars, encouraging them to become more scientific in their observations.

Although it has often been assumed that the vineyards were owned by the Church, it was later discovered on mosaics from the Byzantine period that the inscriptions inscribed on them were names of farmers who owned the vineyards, not the Church. It was the farmers, therefore, that built the churches on their land for God to give them blessings for successful harvests.

The sundial from Amman was presented at our first Archaeological Workshop, which took place in the Al-Hussain Park in cooperation with the local communities and under the umbrella of The Friends of Archae-

ology and Heritage. Its discovery sheds light on reuse strategies in the Late Roman/ Byzantine period in Amman Citadel.

Shape

In general, a sundial consisted of a round plate with a rod known as a gnomon fixed vertically in the middle. Lines were drawn equally on the plate radiating from the gnomon to the edge of the plate showing the 12 hours of each day. Time is indicated by a shadow cast by the sun rays on the gnomon. As the Earth turns on its polar axis, the sun appears to cross the sky from east to west, causing the shadow made by the gnomon to move, indicating the passage of time. The two commonest sundials used were the horizontal, commonly found on pedestals, and vertical, found attached to walls of buildings and churches. There was also the polar sundial aligned with the axis of the earth. Furthermore, sundials had different types of surfaces to receive the sun rays which could have passed through a small hole to increase accuracy or reflected from a small circular mirror. An example of this can be found in a church in the city of Rome today.

Historical Background of Ancient Technology

The earliest sundials known from the



1. World's oldest sundial, from Egypt's Valley of the Kings.

archaeological record are shadow clocks (1500 BC)¹ from ancient Egyptian and Babylonian astronomy. The world's oldest sundial comes from Egypt's Valley of the Kings (FIG. 1). A new study reports on the discovery in 2011 of a carved sundial on top of a Bronze Age grave in the Ukraine that is both horizontal and analemmatic (horizontal sundial with a vertical gnomon that is not fixed, but must change positions throughout the day), and now known to be the oldest analemmatic sundial (Vodolazhskaya 2013).

A stele or a standing stone monolith sometimes served as an astronomical marker for the rising and setting of the sun. In Nabta in the Egyptian Nubian Desert, a stone circle made of small upright stones is probably the oldest monument discovered that was used to observe the moon, stars, and sun (Late Neolithic period, *ca.* 7000–5000 BC). Egyptian obelisks could have been used at temples that honored the Pharaoh to determine the time of feasts and offerings. The simple movement of the sun along the horizon is the religious aspect of the god Re who assists the goddess Nut in performing the task of self-creation (Wells 1992: 305–26; Clegett 1995; 1999; Malville

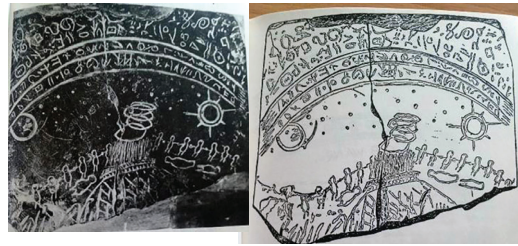
¹ More than 200 Byzantine churches have been identified by excavators (Ababsa 2013: 164). Upon reading the inscriptions, one realizes that the Christian community had a lot of zealots, landowners, farmers, and benefactors to the Church.

et al. 1998: 482–91).

The position of the shadow on the sundial made by the gnomon marks the hour in local time. The idea to separate the day into smaller parts is credited to the Egyptians because of their sundials, which operated on a duodecimal system. The importance of the number 12 is due to the number of lunar cycles in a year and the number of stars used to count the passage of night (Harris 1971: 13–26; Redford 2001: 53; Shaw 2003: 180–1).

At the same time, both the Sumerians and the Akkadians noticed a connection between the movement of the stars and natural occurrences. From here, they discovered how to count, and so mathematics came into use using the mathematical system of 60. There is more than one opinion on this system of calculation which was developed by human beings from ancient periods. If we look to the Sumerians and their sexagesimal numeral system, invented around the third millennium BC, we will see that the Sumerians first invented the time units of today. Water clocks divided the minute into sixty seconds, and the hour into sixty minutes. After this, the Egyptians invented the sundial around 1500 BC. The ancient Egyptians looked to the astronomers to know when to hold specific ceremonies in their temples. The astronomers used the monolithic stone circles as a calendar to calculate the exact time the ceremonies were to be held (Kramer 1981: 153–5).

The Calendar Stele (FIGS. 2–2a) was found in 1847 in Libya and is inscribed in three languages: Egyptian hieroglyphics, Punic, and Libyan written from right to left, and all the inscriptions have the same meaning: the secret of how to regulate the calendar. The hieroglyphs indicate that rays of light fall upon the stone, called the watcher, at the moment of the sun rise on the New Year day which occurred in March (Fell 1978: 6–65). It is one of the most important trilingual stelae ever discovered,



2. Photograph of the Calendar Stele from Libya (from Fell 1978).
- 2a. Drawing of the Calendar Stele from Libya (from Fell 1978).



3. Sundial engraved with a symbol of sun worship, found in northern Portugal (Douro Valley; from Fell 1978).

and it is now in the Putnam Museum and Science Center in Davenport, Iowa.

Another ancient sundial (FIG. 3) is engraved with a symbol of Sun worship, the cultic power found in northern Portugal (Douro valley). It depicts the life-giving rays of the sun descending upon the earth beneath (Iberian Punic 700 BC; Fell 1978: 6–65). Presumably, humans were telling time from the lengths of shadows at an even earlier date, but this is hard to verify. In roughly 700 BC, the Old Testament describes a sundial mentioned in Isaiah 38:8 and 2 Kings 20:11.

A sundial in the Greek style was found among the ruins of Amman citadel (al-Qalāã; FIG. 4). It is dressed stone with a



4. The al-Qalaā sundial.



4a–d. Drawings and photos of the sundial used in al-Qalaā (Amman citadel courtyard or plaza).



4e. Greek hemispherical sundial dating to the Roman period (Archaeological Museum of Piraeus).

frontal face and base, but the backside of the stone is rough so as to engage with a pillar/wall or any part of construction (FIGS. 4a–d). Its height is 49.2 cm, diameter 52.6 cm, and the base is 54.1 cm. There are parallels of this type at Ṭabaqet Fahil, Umm al-Jimāl, and Madaba. The Greeks developed many principles and forms from the 3rd c. BC, and this sundial is a hemispherical Greek type (FIG. 4e). These sundials differ in their portability: a sundial at latitude in one hemisphere reverses to the opposite latitude in the other hemisphere (Oleson 2008). This sundial will be discussed in detail later.

Later, the Roman writer Vitruvius (died *ca.* 15 BC) listed the dials and shadow clocks available at that time. In the follow periods, a canonical sundial was one that indicates the canonical hours of liturgical acts (celebrations). The members of religious communities used such sundials from the 7th to the 14th centuries in Byzantine and Islamic periods. Al Khwarizmi (AD

780–850) mentioned the sundial in the medieval period. Muslims used this device to calculate the time for prayers, especially at the major mosques (al-Hassani 2012: 42). Then, Italian astronomer Giovanni Padovani published a treatise on the sundial in 1570, in which he included instructions for the manufacture and laying out of mural (vertical) and horizontal sundials (Oleson: 2008).

Structures during the Late Roman and Byzantine Periods

During the Byzantine period, a number of Jordan cities became bishoprics. The capital of the Provence of Arabia was established in Bostra, in southern Syria today, which depended on Patriarchate of Antioch. The main source of the economy was farming, cultivating vines, and olive trees, and also production of some copper. Numerous olive and wine presses have been discovered in the rural districts of Rihab,

Al-Samra, Umm al-Jimāl, Umm Er-Rāṣaṣ, and al-Ḥumayma. At churches centered in Pella, Gerasa, Gudara, Madaba, and Petra, an assortment of presses were also found. Many of the Byzantine churches have been identified up to the end of the 8th c. AD (Piccirillo 1993: 566).

During the 5th century until the end of 8th c. AD, Christian communities were in charge of their own religious affairs, especially in the above mentioned cities. A great number of structures, monasteries, and churches were established under the instructions of their Bishops, indicating that they were in an excellent economical and educational situation.

There are numerous archaeological sites in Jordan dating to the Byzantine era, mainly found in the rural areas of farms and villages (FIG. 5):

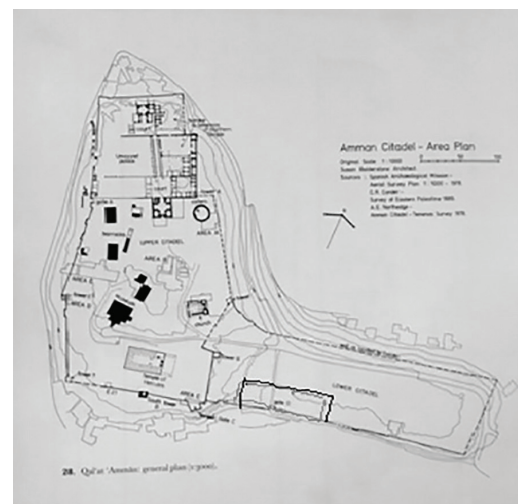
- 1) North Jordan: Gadara, Rehab in Maфраq, Umm al-Jimāl, Khirbat as-Samrā, Pella, Gerasa, and ‘Ajlūn.
- 2) Central part of Jordan: Salt area,

including the Jordan Valley, Dead Sea, and Baptism site, Madaba, Umm ar-Rasasand, and Philadelphia district.

- 3) Southern part of Jordan: Petra and al-Ḥumayma, Feinan, Wādī Araba, including the end of southern part of Jordan Valley (Aqaba).

According to the documents recorded in the Department of Antiquities Information Centre, there is no evidence referring to the position of a sundial in any excavated area, square, or locus. Consulted in particular were the reports of the Jabal al-Qal’ā development project, under the title: Recovering section No. 14 (2000–2004) the second stage, directed by Yazeed Olyan and Husam Hejazeen, and the reports of the previous excavation that occurred in this sector (FIG. 6; Northedge 1992).

The section situated in the southern part of the Amman Citadel (Acropolis), where they rediscovered the Roman Gate (opening from the southern citadel wall and



5. A great number of structures established in Belad Ash-Sham.

6. Section plan No. 14 (2000–2004), the second stage (after Northedge 1992: fig. 28).



6a. Fill which is a result of occupational periods in the citadel.

looking down to the Roman Theatre), was excavated to clean the area between this Gate and where the headquarters and old offices were located. This rubble is a dump fill about 70 m long and about 4 m wide. They recovered parts of the paved Roman road with structural remains on both sides. The fill is a mixture of rough stones and building materials reused through the ages, especially at the later part of Ottoman Period (Sq.29 L4 is a layer about 1.70 m thick). It was in this section (No. 14) that they discovered the Roman steps, which leads up to the Hercules temple. Nevertheless, this fill is a result of occupational periods in the citadel when reconstructed in a traditional pattern as a fortified wall against the Roman gate, especially in the late Byzantine and early Islamic periods (FIG. 6a).

Dr. Fawwaz Khrasheh, who was the General Director of the Department of Antiquities at that time, asked me to be a consultant and expert on this project. On the first visit to the headquarters in 2009, I found this sundial in the passageway between the hangers and the offices (FIG. 4b). I was unsuccessful in obtaining from the excavators and restorers the exact location

of where the sundial was discovered. They said the workers were asked to use the best stone to design the passage around the temporary offices.

Description of the Archaeological Excavation Section of Amman Citadel (Philadelphia) Al-Qala'a

An unexpected discovery was made at the interior line of the southern fortification wall, which could be an early large Byzantine complex with a large platform and irregular openings into rooms which

looked as if it had had some architectural redesigning. The aforementioned sundial likely stood in the center of this complex (FIG. 5), either in a courtyard or market facing south (city center), similar to the Greek one (FIG. 4e), to serve the citizens of Philadelphia especially in the Late Roman period.

Sundials Found in Jordan

1) Amman Citadel. Parallel with: Madain Saleh, Saudi Arabia; Piraeus, Athens, Greece (FIG. 4e)

2) Dar As-Saraya, Sultan Eshraideh excavations at Tabaqet Fahil 1981 (FIG. 7)

3) Umm al-Jimāl church, 2001. Al Mafraq archaeological store. (FIGS. 8 and 8a)

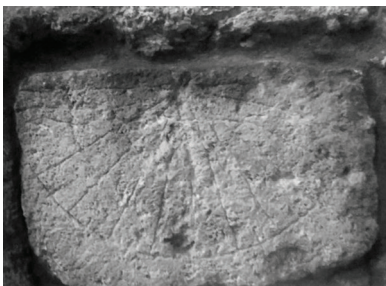
4) Madaba. A sundial found in the archaeological store of Madaba Antiquities office, on a balcony above the ceiling of the Tuwal traditional house, among other archaeological artifacts exposed to the sky. This sundial is the earliest one found in Madaba and is believed to be from the Byzantine era site of 'Uyun Musa, Mount Nebo (FIG. 9). Around 1864, monks and clergymen began visiting the area in search of religious ruins especially around Mt. Nebo and Wādī Musa and 'Uyun Muse (Musa Spring). Saller and Bagatti did some rescue excavations at these sites and collected some archaeological artefacts. To the north of the caves they found isolated ruins of a



7. Dar As-Saraya Sundial, found from local excavation in Ṭabaqet Fahil 1981 by Mr. Sultan Eshraideh.



9. Sundial found in the archaeological store of the Madaba Antiquities Office, at the balcony above the ceiling of the Tuwal traditional building mixed with other architectural elements exposed to open air ('Uyun Musa archive; Mount Nebo).



10. Reused sundial in the Māmlūk reconstruction of Al Qastal Umayyad Mosque. Ahmad Lash discovered it in 2018 as a stone inserted in the interior wall beside the Mihrab and incised by lines. It was a dressed stone from the Umayyad structure (the Umayyad Mosque).



8. Umm al-Jimāl Sundial exposed outside of the Mafrag Antiquities Office in 2001. It was registered there from one of the churches.



8a. Umm al-Jimāl sundial exhibited in the Visitor Center.

monastery with a cemetery nearby. This sundial was found between these ruins.

5) Al-Qaṣṭal Umayyad Mosque. A reused sundial in the Māmlūk reconstruction of al-Qaṣṭal Umayyad Mosque, discovered by Ahmad Lash in 2018 inserted in the interior side of the wall beside the Mihrab (FIG. 10; Lash 2018: 20).

Conclusion

Human beings discovered that to function in cooperation with nature they needed to record time. By observing the movements of the moon, stars, and apparent movement of the sun, they were able to plan their lifestyle and the planting crops, among other things. The invention of the sundial allowed for the accurate timing for religious festivals, the times of prayers, and an organized way of life. This needed the expertise of astronomers, engineers, and religious people who divided time into minutes, hours, and days.

The excavations that took place at al-Qala'ā with the discovery of the Byzantine complex confirms that the sundial would have been erected in the main square or market place facing south, serving the residents of the city.

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