

The Tower Of The Winds In Athens

The water clock and its eight vertical sundials

Efstratios Theodossiou (Athens, Greece), Vassilios N. Manimanis (Athens, Greece), and Petros Mantarakis (Chatworth, California)

Abstract

The Tower of the Winds, still standing in the Roman Forum (*Agora*) of Athens, is a small octagonal marble tower built circa 50 BC by Andronicus Kýrrhestos. On the upper part of each of its sides are carved lines, which indicated the hours of the day using the shadow of iron rods. Moreover, inside the tower there was a water clock (hydraulic clock) to show the time when there was no sunlight. Remnants of the eight sundials as well as the imprint of the water clock and its reservoir can be seen today.

The Roman Forum of Athens

The Roman *Agora*, also known as Forum or marketplace, lies east of the ancient Greek Agora of Athens. It has actually little relation to the Romans, beyond the fact that it took its name because it was built during the height of Roman Empire (1st Century C.E.) in order to serve the growing population of Athens. Its plan was simple but highly functional: a large space surrounded by a rectangular colonnade with the shops arranged behind it. The whole complex has external dimensions 111 by 98 m, while the dimensions of the central space in Roman times were 82 by 57 m. Among the Roman Forum's well-known buildings were the Agoranomeion for the market authorities, the Portico, and the Gate of Athena Archegetis (The Leader). However, the most important and famous building inside the Forum is the hydraulic clock tower of Andronicus Kýrrhestos. It is better known as the Tower of the Winds (modern Athenians refer to it as *Aerides*) due to the personified depictions of the eight winds (blowing from the eight principal directions) and their names, which decorate the top of its sides (Figures 1a, b, c, d, e).

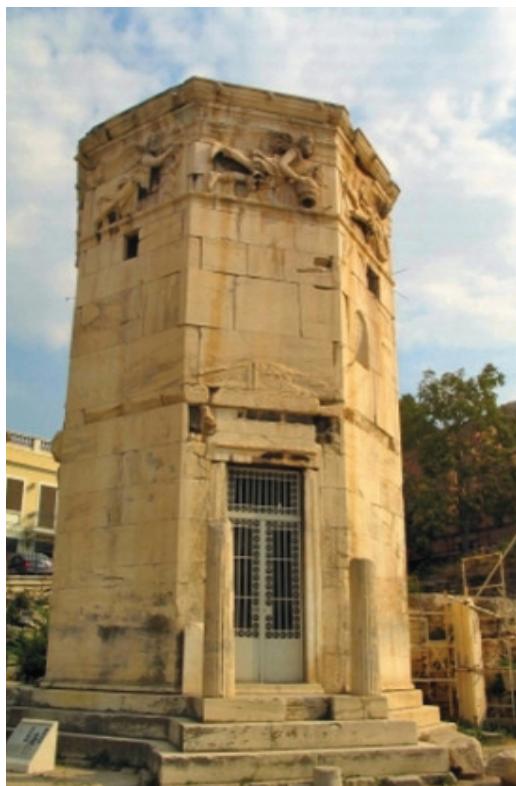


Fig. 1a The Tower of the Winds

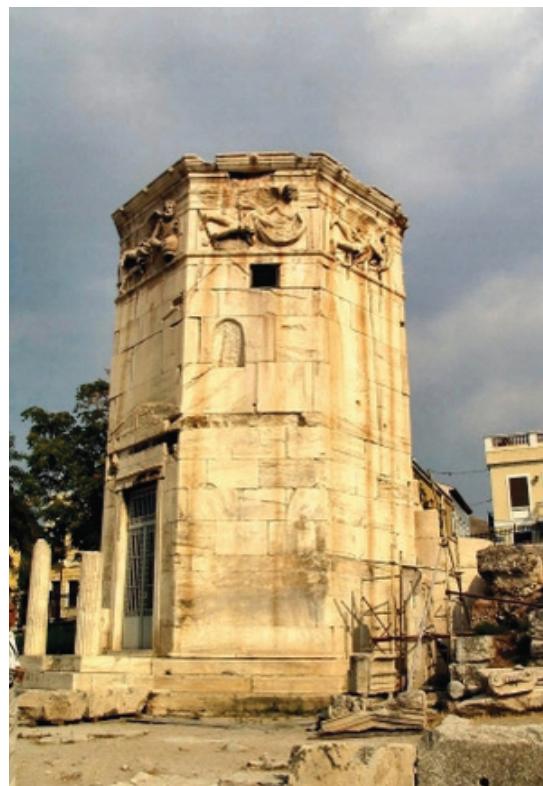


Fig. 1b The Tower of the Winds

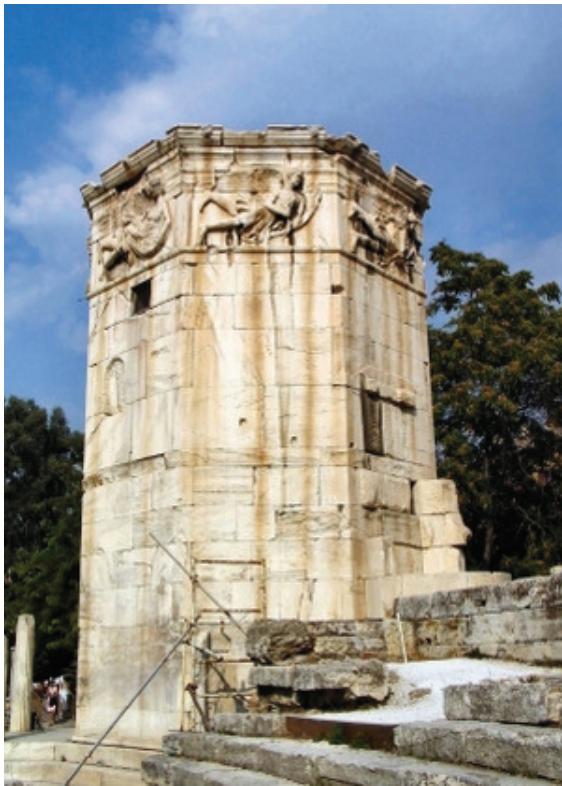


Fig. 1c The Tower of the Winds



Fig. 1d The Tower of the Winds



Fig. 1e The Tower of the Winds

The Tower of the Winds

The Tower of the Winds is located in front of the smaller eastern entrance of the Roman Agora. In fact, it is an older construction than the Forum itself, since it was erected in the 1st Century BC, probably during the reign of Julius Caesar. The monument is made of white Pentelic marble. Inside it, an ingenious hydromechanical system had been built to regulate the flow of water into a cylindrical tank. The level of the water, probably indicated by an outdoor index, showed the time. The designer of this mechanism was also the architect of the Tower itself: Andronicus Kýrrhestos or Kyrrhestis.

A native of the Macedonian city of Kyrrhus in North Syria, Andronicus is cited by Pausanias, Vitruvius and Varro. He constructed celestial spheres and

astronomical instruments, which were often variations and improvements on existing devices; but he is perhaps best known for two more substantial works. The first of these was the white marble sundial he built for the sanctuary of Poseidon and Amphitrite on the island of Tinos, which is now on display in the Museum of Tinos. This sundial became so famous that Andronicus was invited to Athens, where he erected his magnificent tower on the eastern side of the Roman Agora. Being one of the very first "town clocks", it is an octagonal structure, 3.20 m long on each side and 12.10 m high. The total width is 7.95 m. It stands on a base of three steps. Atop its conical roof was a bronze statue of Triton, with a bronze rod in hand, which turned to indicate the direction of the wind (Figure 2). On each facade was a sundial and a winged figure carved in relief, representing one of the eight principal winds. Each of these figures carried



Fig. 4 Copper engraving by Andrea Gasparini (1843)



Fig. 3 The 8 Principal Winds

its own particular symbol, and its name was engraved on the lower part of the cornice beneath it: (counter-clockwise from the North) *Boreas* (north), *Sciron* (southwest), *Zephyr* (west), *Lips* (northwest), *Notos* (south), *Euros* (southeast), *Apeliotes* (east), *Caecias* (northeast) (Figure 3). Andronicus incorporated into this construction a number

of inventions of earlier clock-makers, including Archimedes, Ktesibius and Philon.

Vitruvius (ca 80-70 B.C.E. - ?) called the monument the "Tower of the Winds", and described it in considerable detail; it is also mentioned by Varro. The water for the hydraulic clock was piped in from the spring at the north side of the Acropolis. In the early Christian period, the Tower was converted into a baptismal chapel of an adjacent church, while the area outside the NE entrance was occupied by a Christian cemetery. In the 15th century C.E., Kyriacus of Ancona mentions the monument as a temple of Aeolus¹, while an anonymous traveler refers to it as a church. In the 18th century it was used as the tekke (smoking room) of the dervishes. There is a copper engraving of Tower of the Winds in the middle 19th Century by Andrea Gasparini (Figure 4).

The monument had been half-buried by material accretion over the centuries, and was excavated between 1837 and 1845 by the Greek Archaeological Society. Restoration work was carried out in 1916-19 by the late professor of Byzantine Studies Anastasios Orlandos and in 1976 by the 1st Ephorate of Antiquities. The tower itself, with its Doric interior and its Corinthian exterior, is still in relatively good condition.

The Tower of the Winds is also known as the Clock of Kýrrhestos, since, as we have mentioned, it included a timekeeping mechanism. It was a public hydraulic clock functioning with water being carried into a tank at the Tower's south side. Most probably the water was channeled from the famous spring of Acropolis, known as *Empedò* or as the "Clepsydra of Athens". On the central part of the Tower's floor there are clear marks strongly indicating the existence of the hydraulic clock mechanism. On this topic

there are studies by Derek de Solla Price, Professor of History of Science at Yale University, and Joseph V. Noble, director of the Metropolitan Museum of New York. Derek de Solla Price (1967) succeeded in representing the operation of the hydraulic chronometer of the Tower's interior, which told the time at any part of the day or night. The semicylindrical structure at the left of the Tower contained a water tank (reservoir) and series of floats, pulleys and weights, which generated a force to drive a clock in the whole structure to the right.

The eight sundials

In addition to the water clock, the Tower of the Winds bore eight vertical sundials. In the upper part of all eight sides of the Tower, just under the frieze, can be discerned their carved hour lines. On a clear day, these eight sundials informed the ancient Athenians of the local solar time, even when the sun was to the north side, during the early or late daylight hours of June and July.

As the late Professor of Astronomy Demetrios Kotsakis stresses in his study of these sundials (1967), on the southern side of the monument is carved a system of 11 converging radial straight lines. These are barely visible today but are graphically depicted in Figure 5 (Antonacopoulos G. And Fragakis, H., 1969). The line in the middle is vertical, being the interception of the meridian's plane with the side. The 10 other lines are all symmetrical to the central line. There is also a line parallel to the horizon intercepting the 11 hour lines. There are two more curved lines; they are the curves described by the apex of an

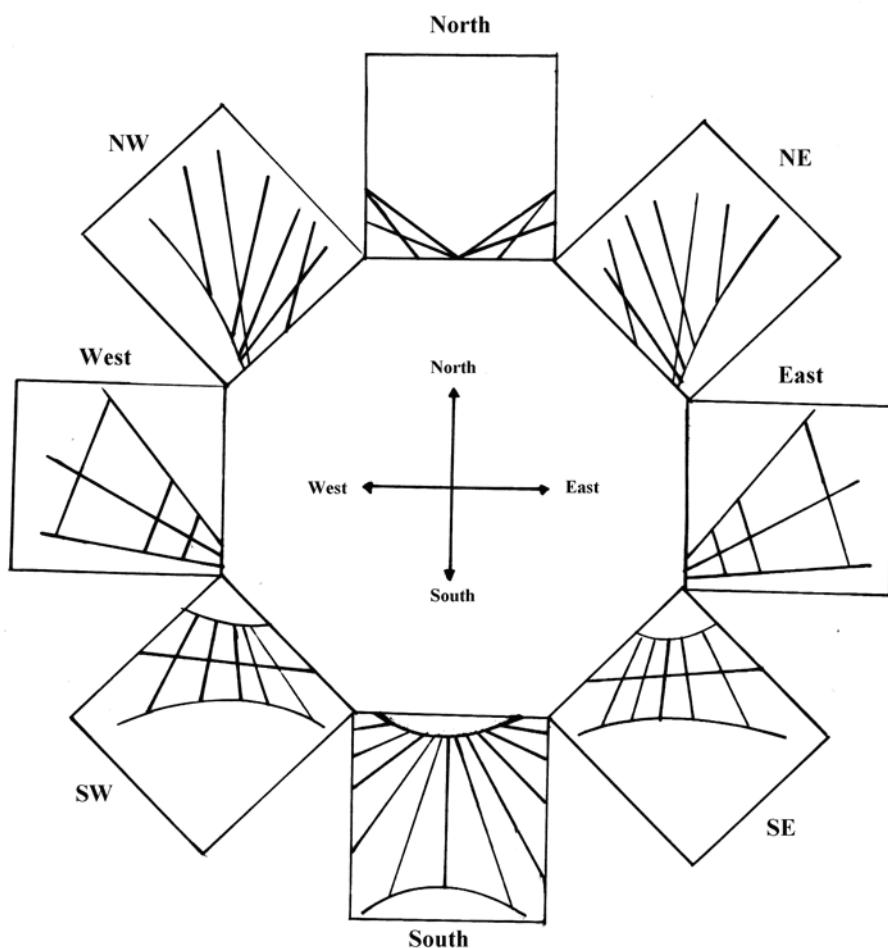


Fig. 5

inclined rod's shadow in the summer and the winter solstices. The straight converging lines end at the lower curve. Thus the southern sundial was showing not only the true solar time, but also the dates of the solstices and the approximate dates of the equinoxes.

The southeast and the southwest sides have 5 converging radial hour lines each and three more lines intersecting them. These are diverging vertical sundials. Again the middle line of the 5 hour lines shows the meridian plane. There is also a horizontal line and the two solstitial curves, having a larger eccentricity than the curves of the south side.

The east and west sides bear only three curved lines each, one showing the date of the equinoxes and the other two the date of the solstices. It seems that originally there were also here two systems of straight lines showing the morning and the afternoon hours, respectively.

The northeast and the northwest sides have different lines, while the north side of the Tower bears three lines to the east of the meridian plane and three to the west. Apparently this sundial was in use from the vernal equinox until the autumnal equinox, and then only during the early or late daylight hours.

At this point it should be noted that probably the sundials were carved one or even two centuries after the construction of the Tower itself. This probability is to be considered because the Roman architect Vitruvius does not mention the sundials at all, although he describes the monument and the carvings of the winds. As the Belgian archaeologist E. Ardaillon writes (p. 260), Vitruvius enumerates in his opus (*On Architecture*) the various systems of clocks known in his time. On the other side, it is possible that he did not mention the sundials of the Tower of the Winds for a certain reason, in which case the sundials are contemporary with the Tower itself. The opinions of the archaeologists are divided on this.

References

- Antonacopoulos G. and Fragakis, H.: The sundial of Andronikos in Athens. *Archaeologika Analecta*. Vol. II, no. 3, part B, Athens 1969, pp. 417-422 (in Greek).
- Ardaillon, E.: "Horologium Solarium", in *Dictionnaire des Antiquités Grecques et Romaines*, par Ch. Dareberg et E. Saglio, tome 3ème Libr. Hachette [s.d], p. 260.
- Derek de Solla Price: *The Tower of the Winds*, National Geographic, April 1967, pp. 587-596.
- Joseph V. Noble and Derek de Solla Price: "The water Clock in the Tower of the Winds", *American Journal of Archaeology* 72, 1968, pp. 345-355.
- Kotsakis, D.: The sundials of Andronicus Kýrrhestos. *Deltion of Geograpikis Ypiresias Stratou* G.Y.S II, 1967, no. 92, pp. 8-9 (in Greek).
- Sharon Gibbs: "The First Scientific Instruments", in *Astronomy of the Ancients* by Kenneth Brecher and Michael Feirtag, The MIT Press, 1979, p. 49.
- Theodossiou, E. and Danezis, E., *Measuring the Timeless Time / Time in Astronomy*, Diavlos Publ., Athens, 1994 (in Greek).
- Vitruvius, *On Architecture*, Harvard University Press, Cambridge 1965.

Efstratios Theodossiou and Vassilios N. Manimanis, Department of Astrophysics, Astronomy and Mechanics, School of Physics, University of Athens, Panepistimiopolis Zographou, 157 84 Athens, Greece and Petros Mantarakis, 22127 Needles St., Chatworth, California E-mail: zanispetros@socal.rr.com

¹ Aeolus was the Greek god of winds. He had been given by Zeus the privilege to unleash and to stop the winds, which he was keeping inside his skinbags. Aeolus offered his hospitality to Ulysses and his companions in the Aeolic islands, the "floating islands" north of Sicily, where he was King. Moved by their curiosity, the companions of Ulysses opened the skinbags of Aeolus prior to their departure, although the King was keeping them secretly, and the winds were unleashed on the islands to their punishment.