

Istanbul Sundial Tour by Roger Bailey

On your first morning in Istanbul, you will rudely awaken. “Great God! It’s the middle of the night” you may exclaim. Your hotel is within shouting distance of a mosque. Welcome to Istanbul, the world of Islam and the daybreak call to prayer. Allahu Akbar! الله أكبر God is great.

Istanbul and Turkey are among the most interesting cities and countries in the world to visit, with layer upon layer of history, empires, architecture, religion, culture, peopleand sundials. OK, sundials are not on most peoples’ itinerary but perhaps you can use the call to prayer as your inspiration. How did they determine the time of daybreak? It seems like the middle of the night and the time varies with the seasons. This question drove the development of astronomy and science just as the determination of Easter and the revision of the calendar drove Christian medieval astronomy. In both cases sundials provided the answer. On this sundial tour of Istanbul you will learn how Islamic astronomers, the mosque timekeepers, used sundials to determine all the Moslem prayer times, including daybreak and nightfall when the sun is well below the horizon.



Tours usually start at Sultanahmet Square, the centre of the Roman Byzantine Empire since 324 and the Ottoman Empire from 1458 until WWI.

The sundial tour goes to the same sites as the standard tours but you can add features unknown to the tour guides. As you visit marked on the map, the Blue Mosque, Hagia Sophia, Topkapi Palace and the New Mosque, you can find details hidden from casual view but important for understanding the fundamental question for Moslems, “When do we pray”. You will see sundials ranging from the most elementary scratches on a wall to the most complex with two gnomons showing time in four different systems including Moslem Prayer times.

Click the map for a live Google Map.



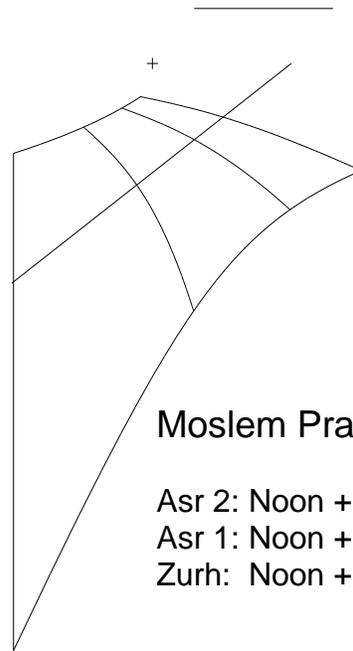
Constantine moved the centre of the Roman Empire here to the Greek city of Byzantium in 324. Rome could no longer be protected from waves of invasions by Goths, Huns, etc from the northeast. Constantinople, on the eastern edge of what is now Europe, remained the Christian centre of the Roman Empire until 1453 when it fell to the Ottoman Turks, Sultan Mehmet II, the Conqueror. There are many remnants of the Byzantine Roman Empire in Istanbul such as the prominent Roman monument at the Hippodrome, the Obelisk of Tutmoses III. Was this obelisk ever used as the gnomon for a sundial like the similar Tower of Augustus in Rome, a 30 m Egyptian obelisk moved to Rome in 10AD? Unlikely! The original grade level is now buried by centuries of dust so it is difficult to check for hour lines or meridian marks. We will see a Roman sundial later but first lets move from the square to the famous Blue Mosque.

Blue Mosque Sundial:



The impressive Blue Mosque with billowing Byzantine domes was built in 1609-1616 for Sultan Ahmet I by architect Mehmet Aga. The six minarets tell you that this is the Sultan's mosque, the main mosque of the Ottoman Empire and now the national mosque of Turkey, the largest in the country. The Sultan Ahmet Mosque is called the blue mosque due to the blue tiles decorating the interior. This is one of the highlights for any tour to Istanbul.

There is a minor detail unknown to most people on the southwest wall, above the area where devout Moslems wash their feet before entering the mosque. You can see an iron rod projecting from the wall, the gnomon for a primitive sundial showing Moslem prayer times. The wall faces south declining 42° west. The lines on this triangular afternoon dial are the vertical meridian noon line, solstice and equinox declination lines and hour lines for the noon prayer Zuhr, and the start and end if the afternoon Asr prayers. The prayer times are defined by the shadow lengths for a vertical gnomon on a horizontal dial. The usual definitions are: Zuhr as the noon shadow plus $\frac{1}{4}$ the gnomon height; Asr start as the noon shadow plus the height of the gnomon and Asr end as the noon shadow plus twice the gnomon height. In itself this roughly carved sundial is insignificant, just old scratches on the outer wall of the Mosque. The significance is the fact that it exists and it tells us to look for such sundials on other Mosques. We will find many more sophisticated dials of this type on other mosques, all with the same horizontal gnomon and triangular shape.



Moslem Prayer Times

- Asr 2: Noon + Gnomon
- Asr 1: Noon + 2 gnomon
- Zurh: Noon + ¼ Gnomon

After visiting the mosque, cross the street on the north side to view the greatest example of Byzantine architecture, “Hagia Sophia”.

Hagia Sophia Sundial:

The highlight of every tour of Istanbul is Hagia Sophia, the Basilica of Saint Sophia, the Temple of Holy Wisdom, the largest masonry dome in the world. Hagia Sophia was commissioned by the Byzantine Emperor Justinian and built in 532 – 537 AD. This epitome of Byzantine architecture was designed by Isidore of Miletus, a physicist, and Anthemius of Tralles, a mathematician. The Basilica of Saint Sophia, the Temple of Holy Wisdom, the largest masonry dome in the world. Hagia Sophia was commissioned by the Byzantine Emperor Justinian and built in 532 – 537 AD. This amazing structure has withstood 15 centuries of weather, earthquakes, schisms, iconoclasts, conversions and wars. The Christian church was converted to a a mosque following the conquest of Constantinople in 1458 by the Ottoman forces lead by Sultan Mehmed II. The beautiful mosaics were covered with plaster and remained invisible but protected until Hagia Sophis was



converted to a museum of the Republic of Turkey by Atatürk in 1935. The historical mosaics are now revealed in all their glory. Enjoy your tour.

As you leave after the tour, turn around in the courtyard of the foot washing fountain and look for a small tablet on the south facing wall declining 36° west. This obscure feature is the Hagia Sophia sundial. The curved lines show the time of the afternoon prayer, Asr, the start time, when the shadow length is equal to the noon length plus the height of the gnomon, the end time when the shadow is the noon shadow plus twice the gnomon height, The other curved lines are times before Asr in equal 20 minute intervals. The vertical noon meridian is evident as are the declination lines for the solstices and equinox. Modern computer analysis shows the lines are mathematically correct. The dial is no longer accurate because the gnomon is drooping, bent down from its erect horizontal position. The midday Zhur prayer time is not evident on this sundial.



4. ***Topkapi Palace Sundials:***

Continue the tour across the next road to the Topkapi, the Palace of the Sultans and centre of the Ottoman Empire. Most people tour Topkapi to see treasures of the Ottoman Empire and the famous harem where the Sultans kept their hundreds of wives, concubines and their families. For me the two sundials are the treasures. The sundials are in the Third Courtyard of the Palace, past the museums and harem buildings, just outside the clock museum. This location is at the far end of the site, about 650 m from the entrance gate. Pass through the Gate of Felicity and go left past the Throne Room to the sundials in the Third Courtyard. On your left will be the famous Ottoman sundial on a pedestal with steps and protected with a plastic cover.

The Ottoman sundial was created by Suleyman Bey, Secretary of the Treasury for Sultan Mehmet II about 1480. It is a complex horizontal sundial with two gnomons and four time systems. The design is based on Ibn Al Shatir's sundial at the great mosque in Damascus. Shatir introduced the polar gnomon and his dial made in 1371 was one of the first with a polar gnomon.



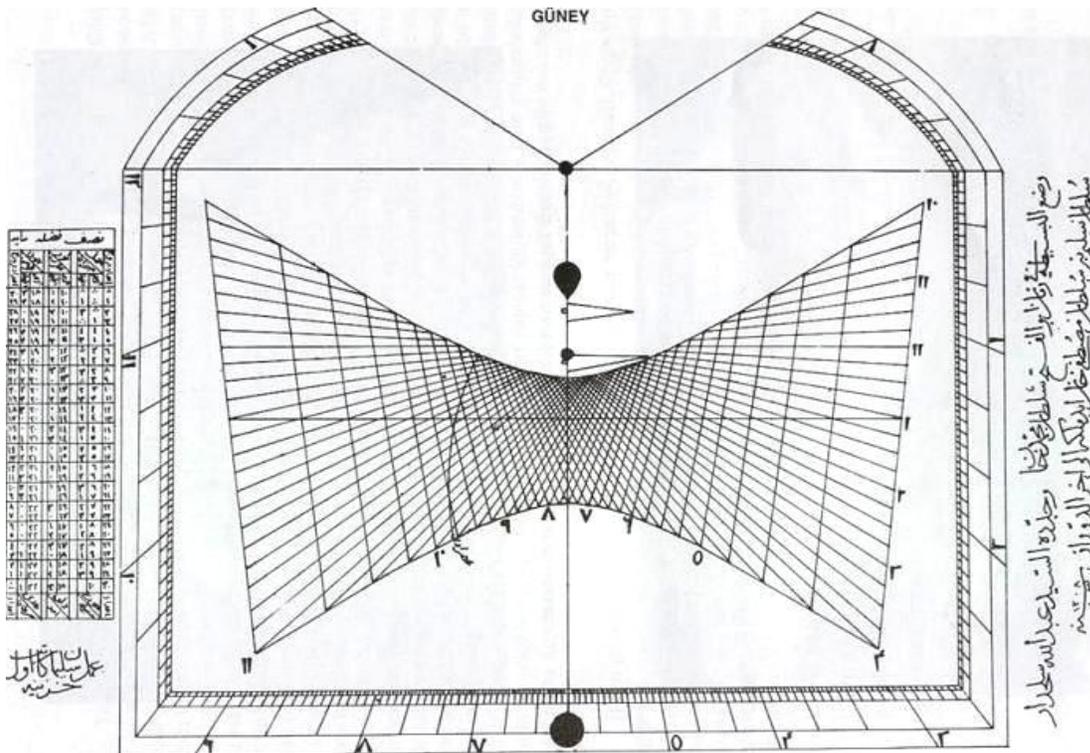
This picture is from Joel Robic's [Sundial of the Moon](http://www.sundialofthemoon.com) website.

Shadows from the polar gnomon on the outer scale for equal hours base on noon.

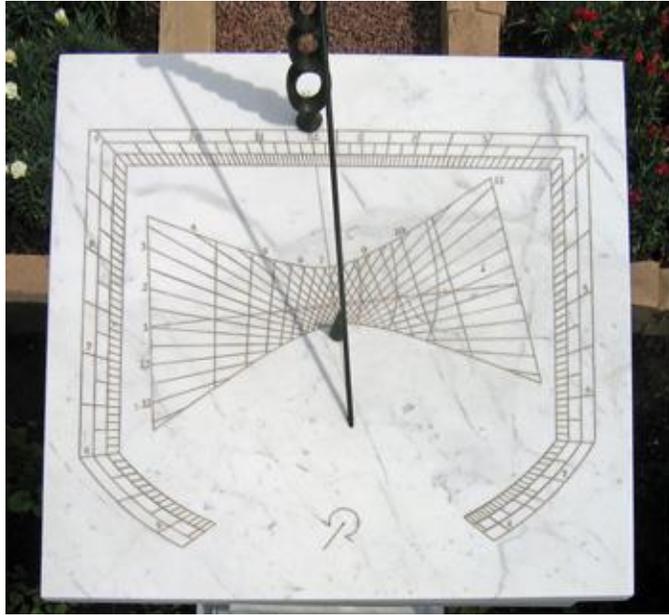
The short vertical gnomon casts shadows onto the hour lines forming the butterfly pattern.

Babylonian hours start at sunrise. Italian hours are the reverse, starting at sunset. Noon varies with the seasons but all three time systems are the same at noon on the equinox. The declination lines are shown for the solstices and the equinox.

The drawing below originally from the Palace archives shows the details design. The normal point of view from the south is at the top of the drawing. Arabic script is also backwards by western conventions.



There are several sundials based on this design around the world. The latest was designed by the author, Roger Bailey, sculpted by Abraham Mohler and installed in the Ottoman Garden of the Missouri Botanical Gardens in St. Louis in 2008. The pictures below show Missouri Ottoman Sundial.



Also in this courtyard of Topkapi Place is a historic Roman Scafe sundial. Look for a large block of stone across a walkway, to the south west of the horizontal Ottoman sundial. The Roman Scafe sundial is a large stone, flat on top with a large sphere carved in the front. The south-facing front is cut on an angle or scafe. The time lines are engraved on the circumference of the inner sphere. There seem to be 12 hour lines with 6 less evident divisions, 10 minutes each. These lines are sloped from top left to lower right as the dial with slight curvature at the ends. The necessary point gnomon in the middle of the horizontal is missing. In this picture from Joel Robic's [Sundial of the Month](#) website you can see the Ottoman horizontal dial in the background, upper left.



As it sits this sundial is incomprehensible for most visitors including me. Perhaps if you flipped it over, tilted it up until the safe surface was flat and oriented with the base of the safe north, it would work. In the equatorial plane with gnomon tip in the center of the sphere a shadow of the tip would trace the time each day, parallel to the tilted surface but moving up or down with the seasons and solar declination. Even hours based on noon would be straightforward, parallel to the noon line, with more hours in the summer than winter. But the engraved lines are slanted and noon shifts with the seasons. The lines seem to be equal Italian hours based on sunset. One odd curved line in the afternoon may be a crack in the rock or perhaps an Asr line added in Ottoman times. Further analysis is required and beyond the scope of this sundial tour.

The next important sundial site is less than a mile away, just down the hill to the west. Unfortunately that is as the crow flies. You will have to retrace your step and exit the normal way, as there are no shortcuts. The next destination is the New Mosque. Take the tram down the hill and past the train station, the terminus for the Orient Express. This is boundary of Europe with Asia across the Bosphorus Strait.

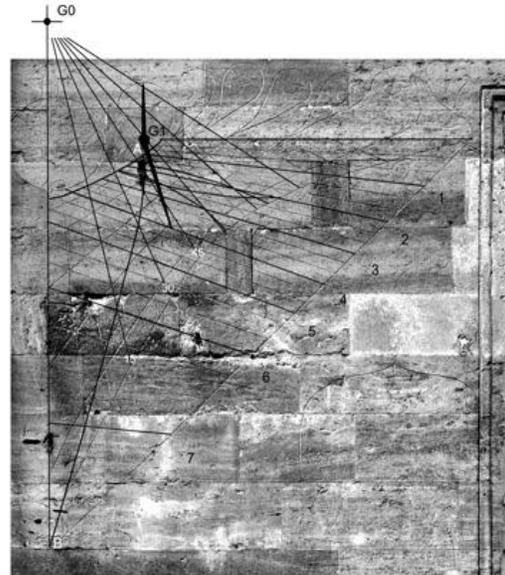
New Mosque Sundials:

Down at the bridge, the port and across from the Spice Market is the New Mosque, “Yeni Camii”, completed in 1663. Here hidden in plain view are three important sundials that show the culture of the times in the Ottoman Empire, These three sundials are carved into the south west wall facing of the mosque, just above the foot washing fountains. Here we find an Islamic sundial, a Western sundial and a combination like the Topkapi Ottoman sundial with combined time systems. The sundials are large but the lines are difficult to spot unless the sun is on the side creating distinct shadows. Look for the gnomons sticking out from the wall.



All three sundials have the characteristic triangular shape and are afternoon dials on the wall declining 45° west of south. The dial on the left at the corner is the most complex and interesting. This looks like the typical Istanbul vertical triangle sundial. Like the Topkapi Ottoman dial, this sundial shows Western hours, Italian hours, Asr prayer times and declination lines. On the site and in the original photo lines you can see an array of very interesting lines invisible at the resolution available here. Click on the dial picture

I shared the original photographs with an Italian colleague, Gianni Ferrari, an expert on Islamic sundials. He analysed the images and he provided an overlay that showed two of the faint lines were associated with the prayer times, Fajr at daybreak and Isha at nightfall. Gianni showed that the line coming down from the gnomon and turning towards the meridian is 14 hours before Fajr based on the sun being 19° below the theoretical horizon. Similarly the line between the two Asr time lines but curving the other way is the shadow point at 4 hours before Isha, with Sun's altitude at -17° . There is a precedent for these lines referencing times when the sun is below the horizon the Ibn Al Shatir sundial at the great Mosque in Damascus has similar lines as do several others in the Moslem world. Click on the right picture for a large clear image.



The horizontal line from the gnomon would mark sunset the Maghrib prayer time. This remarkable sundial seems to have references for all the Moslem prayer times: Fajr daybreak, Zuhr noon meridian, Asr mid-afternoon, Maghrib sunset and Isha nightfall. It is amazing what you can learn from the shadow of a stick!

The next dial along the wall to the right looks more conventional. It has two gnomons. The larger one should be a polar gnomon but some ignoramus has bent it up to look like a Moslem gnomon. Usually age and gnomon dysfunction causes gnomons to droop. This one is bent erect. The hour lines for this gnomon are equal hours based on noon, The short peg perpendicular to the wall is not a support post but a gnomon that indicates the Asr pray time. The details seen in the field and on the original photos are quite interesting. Click on the picture for a clear view.



The third sundial along the wall is even simpler, with one horizontal gnomon and one set of lines. These are the mid-afternoon Asr prayer time, start and end as well as time before the prayer time in 20 minute intervals. The date lines for the solstice and equinox frame the time lines. The little cap on the top Asr line is thought to be a stylized Asr in Arabic script. This symbol is seen on several Istanbul sundials. Click on the picture for a clear view.



On this one wall, from right to left, we have a Moslem prayer time dial, a western hour dial, and a complex combination sundial.

The few sundials described on this short tour are not unique. There are similar ones on the Suleymaniye Mosque visible on the hill to the southwest and other Mosques in Istanbul. I have seen the sundials at Suleymaniye and Fatih but not those at Murat Pasa, Sultan Selim, Sultan Ahmet, Beyazit, Suleymaniye and Ayasofya. The best is reported to be across the Bosphorus on the Mihrimah Mosque in Uskudar. So many sundials. so little time! Most are triangular vertical sundials declining west of south, engraved on the wall or on stone tablets. The characteristic triangular shape is set by the declination lines, the meridian and sunset.

Take some time and enjoy exploring the cultural wealth in this city, from so many points of view. For Islamic science, specifically astronomy, and mathematics is interesting to learn what they knew and when they knew it. It is also important to ask why they stopped advancing in these and other areas of science, art and culture.

One good reference is: Principle and Use of Ottoman Sundials By Atilla Bir*
<http://www.muslimheritage.com/topics/default.cfm?ArticleID=942>

I look forward to Gianni Ferrari publishing his extensive research as a book.

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Walking Shadow Designs www.walkingshadow.info

