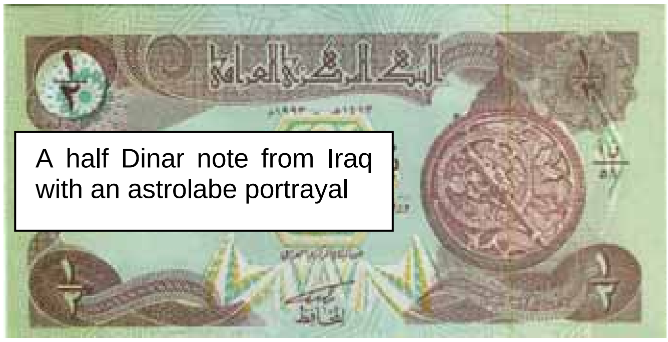
THE PLANISPHERIC ASTROLABE

Feb 4, 2006

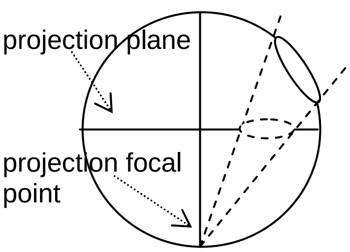


A half Dinar note from Iraq with an astrolabe portrayal

Of old, the astrolabe was used for various astronomical and astrological calculations, In particular, it could also be used to determine the time from the sun's altitude, which when corrected for the equation of time and longitude, would provide the legal standard time.

Unlike the altitude devices discussed elsewhere, this device is directly based on the ecliptic, and since the earth and the sun are always on the ecliptic, and since the ecliptic moves by the second, minute, and hour, the sun's altitude pinpoints an ecliptic point, and together with the rest of the magic of the astrolabe, the time is hence derived. Most astrolabes not only have the ecliptic, they also include the stars. The planispheric astrolabe, described here, uses a "projection" of the earth and the celestial sphere to the equator. Another variant uses the Saphea projection onto a vertical plane.

The theory is that projecting onto a circular slice of a globe perpendicular to a projection focal point, results in circles on the surface being preserved on the projection plane, angles similarly .



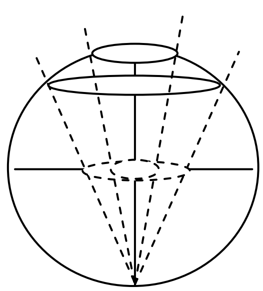
latitude 33° circles

A circle is placed on the globe at latitude 33° for example, and lines drawn from the perimeter to the south pole in this case as a projection focal point. Those lines will intersect the equatorial plane and still form a circle. If several circles are projected, then several circles are the result, however, their centers on the equatorial plane may not be co-located, they may be offset.

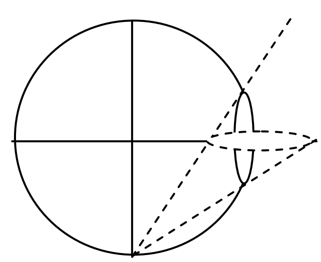
If those circles were at latitude 90, it is obvious that the projection would be circles, and in that specific case they would also have a common center.

If the circles were on the equator, and projected to the equatorial plane, i.e. a 90 degree projection, they would still be circles.

The secret is to look at the projecting lines as a cone, and the projection is always the same angle of slice on that cone as are the original circles.



latitude 90° circles



latitude 0° circles

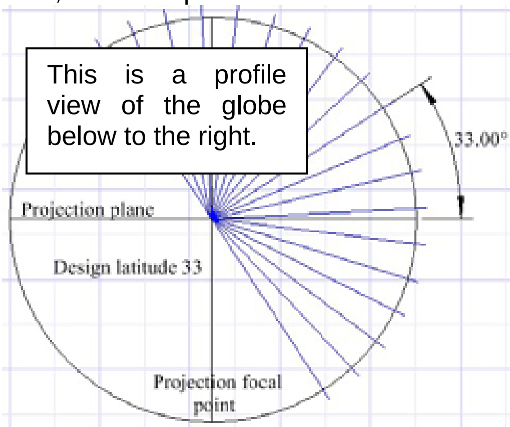
There are more rigorous proofs, mathematical and geometrical, however this explains the principle of stereographic projection as it is called.

The second key point is that the celestial sphere, stars and the ecliptic will exist on the surface of the globe. The third key point is that the ecliptic will be a plane slicing through the globe as a great circle whose angle of slice will be 23.5 degrees, being the earth's polar axis offset from the plane of orbit, the ecliptic.

Astrolabes consist of pieces. The part that holds everything together is the mater, from the Latin for mother. Resting in or on the mater is a plate having projected circles depicting altitudes from the horizon, called almucanters. They are part of the time telling secret. And rotating on the almucanter plate, sometimes called a climate plate, is what is called the rete. The rete has the ecliptic circle on it, and sometimes the stars.

Using the astrolabe is simplicity itself. The sun's altitude is measured, usually by a simple protractor system on the back of the astrolabe. And then the rete which has dates on the ecliptic circle, is rotated until the date touches the sun's altitude circle (almucanter) and their intersection when extended to the outer circle on the mater from the center, depicts the local apparent time.

First, a climate plate must be constructed for the desired latitude.

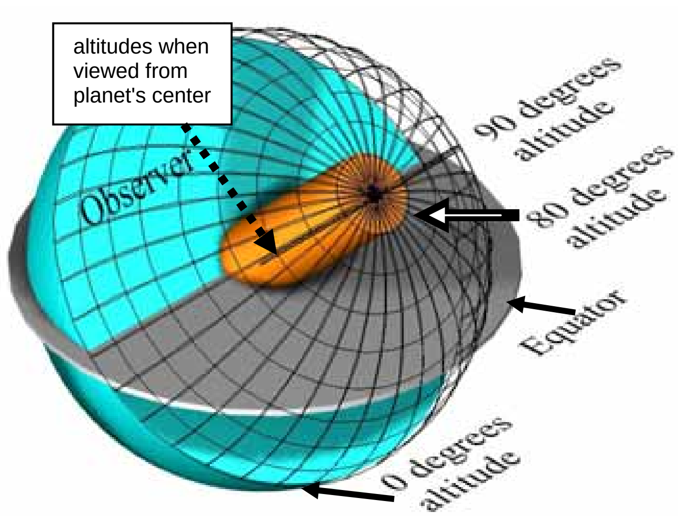


A circle is drawn representing a vertical slice of the planet, a north south line and an equator line are drawn. Then a line for the desired latitude, 33° in this case.

Then circles of altitude are drafted, depicted by two limiting lines, in this case they are 10 degrees apart. Two or five degree separation is more practical.

These are circles depicting altitude. The altitude they depict inversely matches their north/south distance from the observer. So 0° from the observer is the 90° altitude almucanter, 90° south of the observer is the 0° almucanter, etc.

To the right is the planet earth with the equator, and part way up the globe is a cylinder depicting 80° of altitude, or 10° from the observer's vertical.



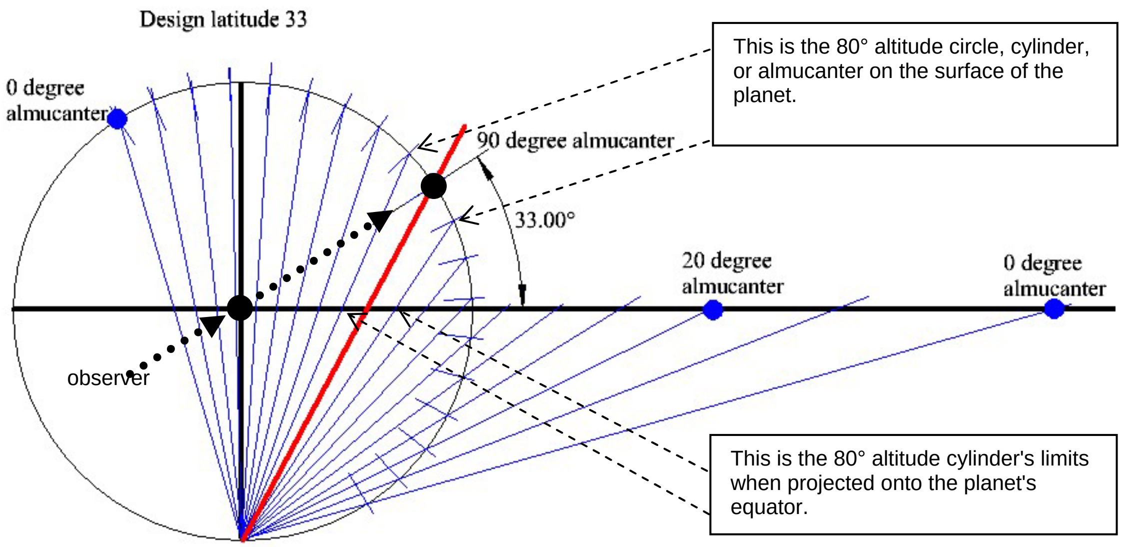
Those angles are altitudes seen by an observer on the surface of the planet at the center of all those circles. The picture to the right simplifies this by placing the observer in the earth's center.

The planispheric astrolabe only uses two key concepts in it's design.

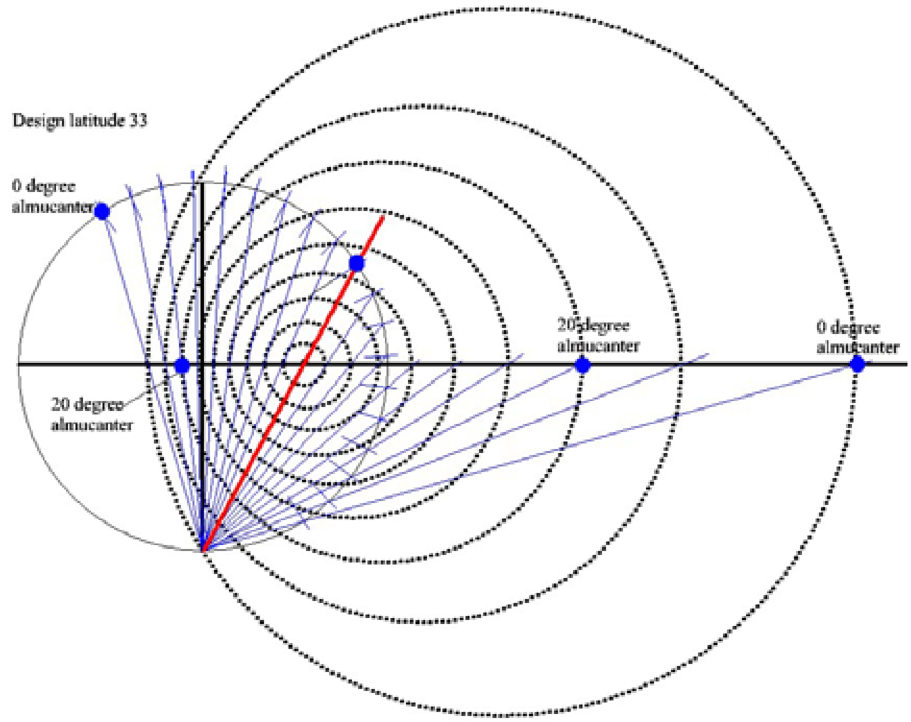
First those cylinders of altitude which are circles on the surface of the planet, are reduced to projected circles on the equator, and they become the climates or the plate with the almucanters, or altitude circles. These are sometimes confused with latitudes and they are not, however, each almucanter of n° is 90-n° from the observer on the observer's meridian or line of longitude.

Second, the ecliptic is reduced to scale using the same globe profile as for the climate or almucanter plate, on a movable plate called the rete. The next pages discuss this transformation.

The profile of the planet is drawn, as shown on the previous page. This has the altitude circles or cylinders, called almucanters. Then they are projected to the equator, as shown below.



When all altitude circles are completed, i.e. their lines projected to the equator, then those limits are used to draw the final circles for the climate plate. Above only the 10° increments are shown, with 2° being more common, This is done by drawing a circle, placing it's left side on one of the projected circle's limits, and it's right side similarly.



All the desired circles are drawn and then printed onto a dial plate, the climate plate, ready for use.

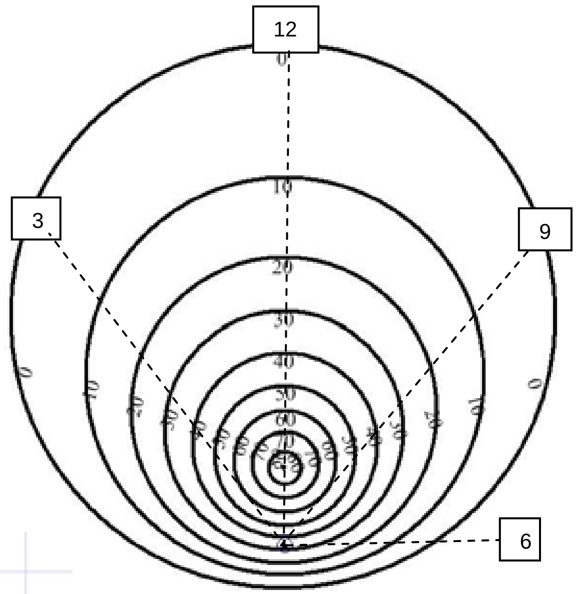
A point is drawn on the altitude circle or almucanter at the altitude equal to the latitude of the observer, or the dial plate or climate plate's design location. That point will be the center of the final climate plate, and around which the ecliptic rete plate will revolve. Hour lines of 15° radiate from that center on the climate plate, and will be the final hour lines, they usually exist on the mater however.

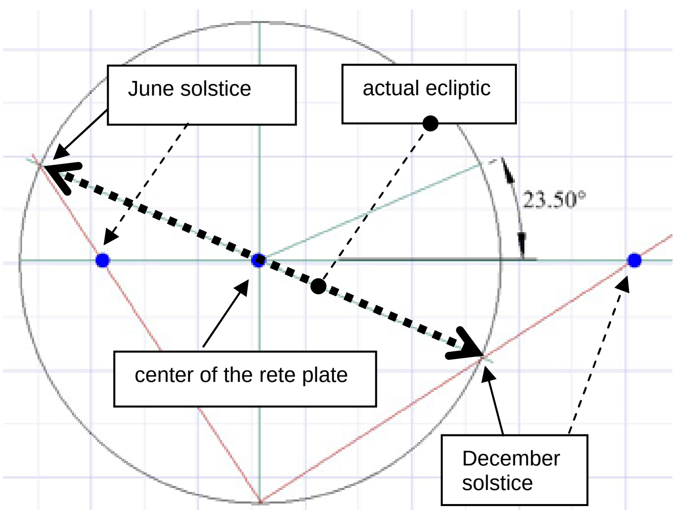
To the right is the final layout for the climate plate holding the almucanters. Hours can then be marked on 15 degree radials from the almucanter matching the latitude of the observer, not from the zenith, or they can be added to the mater plate later.

The scale for the climate plate almucanters and the scale for the second and last plate, the rete which holds the ecliptic, must be the same.

The center of the 15 degree radials, which is the almucanter matching the observer's latitude, will also be the center of the rotating rete.

Next, draft the latitude independent rete.





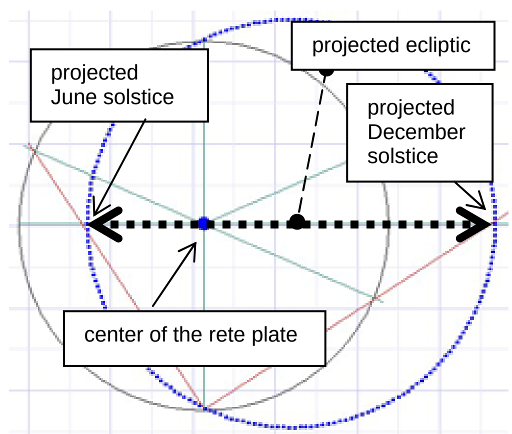
The same circle used for initially projecting and drafting the altitude lines, is copied retaining the scale.

From the center of that new circle is drawn a line at 23.5° line from the equator, being the ecliptic.

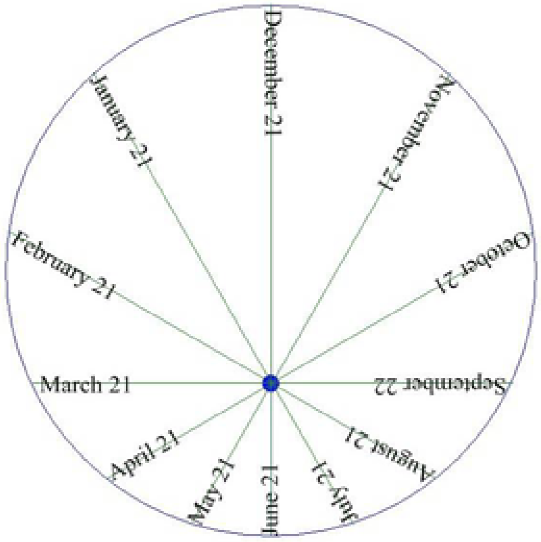
For the northern hemisphere, the upper part that intersects the circle is the June solstice. When projected, this will be the June 21st date on the rete, or projected ecliptic.

The lower intersection will be the December solstice. In the pictorial above, the ecliptic plane is projected to the equatorial line, a rete plate center located, and the limits of what will be the ecliptic circle are identified. Just as for the climate plate, and retaining the scale, the ecliptic circle is drawn. This is a circle and not an ellipse, the ecliptic being a collection of ecliptic intersections on the globe or planet, which forms a great circle, hence why a circle is used.

The final rete plate, whose scale is retained, is then printed onto a final plate. Note that it's center of rotation is offset.



Just as hours were added to the 15 degree radials on the climate plate, dates are added to the rete. The June solstice is June 21, the December solstice is December 21st. Scale is critical, however some editorial resizing occurred in the above drawings.

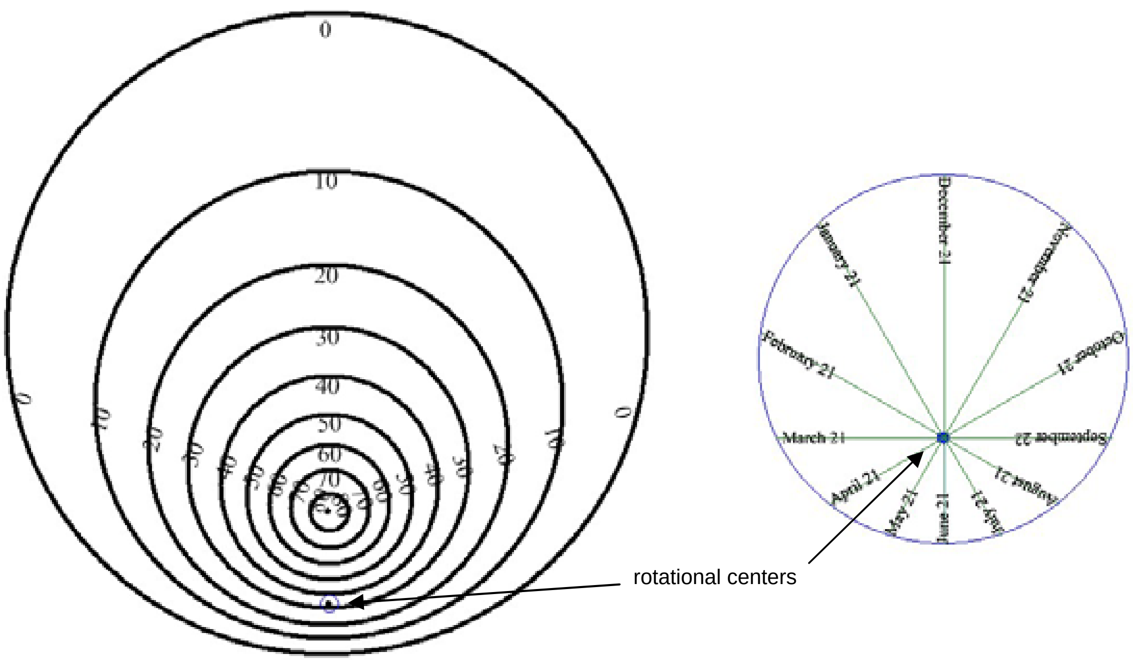


Here the dates have been added in. Of course, the dates are symmetrical, thus March and September and their intervening dates can be swapped should you so wish.

Most astrolabes use the zodiac calendar on the rete plate, and the back side of the astrolabe has a conversion from the calendar in fashion at the time, to the zodiac. So take the "21" of the month, as shown, with a pinch of salt.

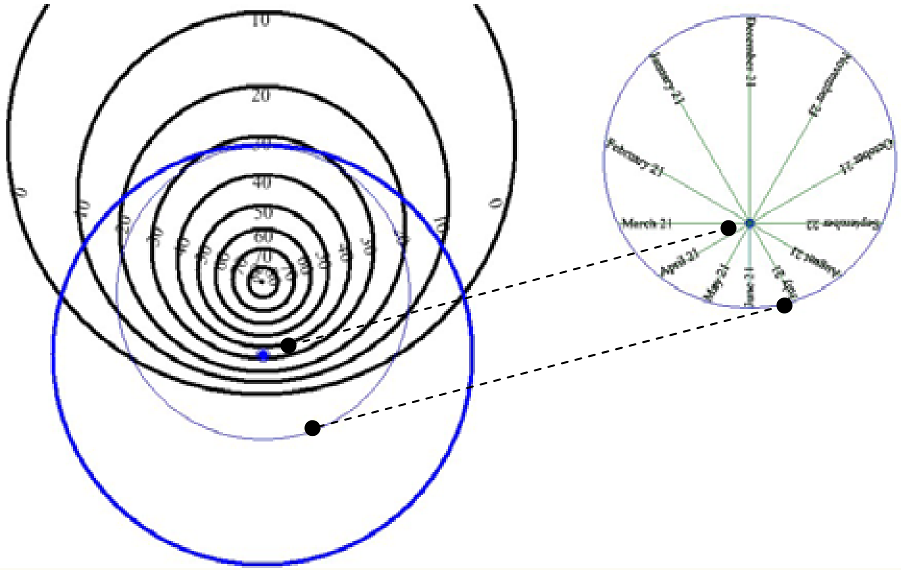
Similarly, the hours on the mater plate are traditionally shown clockwise, however they can be reversed. It all depends on how you make your rete rotate to intersect with a solar altitude curve or almucanter.

The final rete is cut and mostly consists of empty space to the almucanters can be seen.

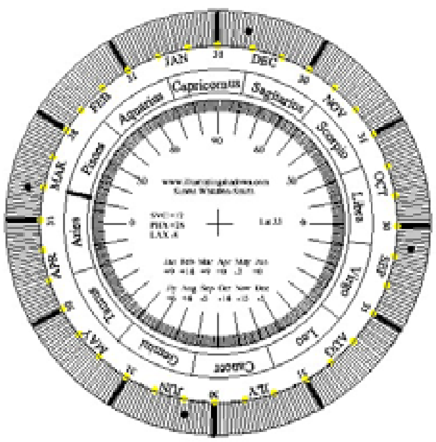


Above are both the climate plate on the left and the rete on the right, scale retained. All that is needed is for the hours to be marked on the 15° radials of the climate plate, they will be projected to the rim of the mater. From the rotational center of the climate and rete plates is usually attached a rule so the intersection of the sun's altitude with the date can be projected to the outer scale displaying the LAT.

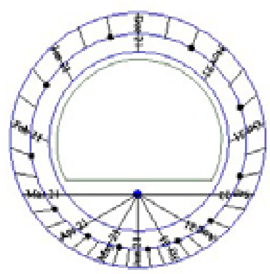
The back of the astrolabe usually has an altitude measuring protractor, and often a conversion from the normal calendar to the zodiac. An equation of time table may be added, and a table of longitude differences for places on the design latitude similarly.



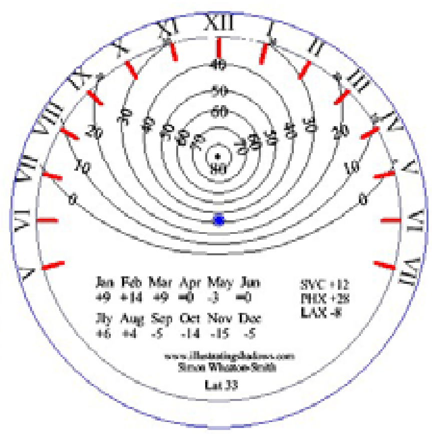
The circle of the rete and its rotational point are copied to the climate plate because the rete's center is located on the almucanter associated with the climate plate's design latitude. Then, a circle is drawn from the rotational center to the limit of the rete, this last circle is the final climate limiting circle, and outside of that will be the mater. And hours are added as 15 degree radials from the rotational center. That mater's outer circle can be bigger than the rete's limits, not smaller. If bigger then it is easier to see where the rete is in relation to the almucanters.



The back of the astrolabe has date conversions, the EOT, and altitude protractor



The rete is latitude independent and has the dates



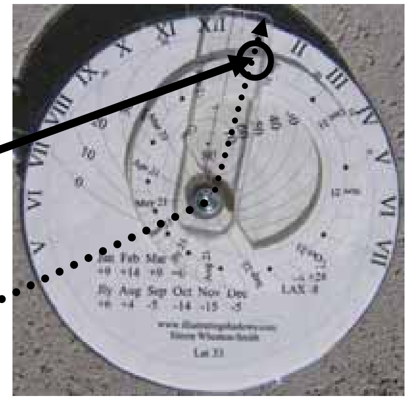
The outer periphery is the mater, enclosing the climate or almucanter plate of sun altitude lines

The above is the mater (outer area with the hours marked), within which is placed the climate or almucanter plate, which is fixed, and on that is the rete which rotates. It's date is set to the sun's altitude on an almucanter arc, and a line projected from the rotational center indicates the local apparent time on the mater. All that is needed is a rule to help point the time, and on the back, a protractor and alidade, the alidade is the name for the altitude measuring rule. The equation of time may be added, and other dial furniture.

The completed astrolabe in use is shown below. The altitude was found using the back, and the date and altitude made to meet on the front, and that when projected to the mater indicates the time.

To the left is the alidade showing 35 degrees of sun altitude.

To the right, the rete's date is rotated to the almucanter for the 35 degree sun altitude. The intersection when extended shows the LAT and when longitude and OT are considered, the legal standard time.



Sunset can be determined by moving the date on the rete to intersect with the 0 degree altitude line or almucanter. That intersection when extended to the mater from the rotational center will provide the LAT for sunset, or sunrise.

There is little written on the astrolabe design. However there is a good article on stereographic projection for the climate plate at::

http://www.math.ubc.ca/~cass/courses/m309-01a/montero/math309project.html

And an astrolabe generator is available at:

http://www.uwsp.edu/physastr/rislove/astrolabe/resource.htm

Another set of resources on astrolabes may be found at:

http://www.astrolabes.org/links.htm

Commercially available astrolabes can be acquired from

Norman Greene, 1215 4th St., Berkeley, CA, 94710
http://www.puzzlering.net/astrolabe.html

and also from

Saunders & Cooke, P.O. Box 1459, Portsmouth, NH, 03802-1459
http://www.saundersandcooke.com

While the Norman Greene astrolabes are smaller and less detailed than some others, and while many commercial astrolabes suffer from a bright climate plate or plates with hard to read markings, the Norman Greene astrolabe is possibly one of the most practical commercial astrolabes to use overall. Until the TSA screeners at airports became suspicious of mine, I used to travel with it for many years.