Basic Geodesy

Issue 1 February 2005

Shape of the Earth – A Sphere?

Erastothenes (~250 BC)

Roger Foster
Coordinate System Analysis Team (CSAT)

Erastothenes was a scholar who lived in Alexandria in ancient Egypt about 230 BC. He read that on the longest day of the year, the sun's reflection could be seen at the bottom of a deep well in Syene, (now called Aswan), a city south of Alexandria. However, he knew that there was a definite shadow cast by the sun at the same time in Alexandria. (See Figure 1)

Erastothenes reasoned that if the Earth were flat, as was widely believed at this time, this situation would be impossible. This led him to the conclusion that the Earth is a sphere.

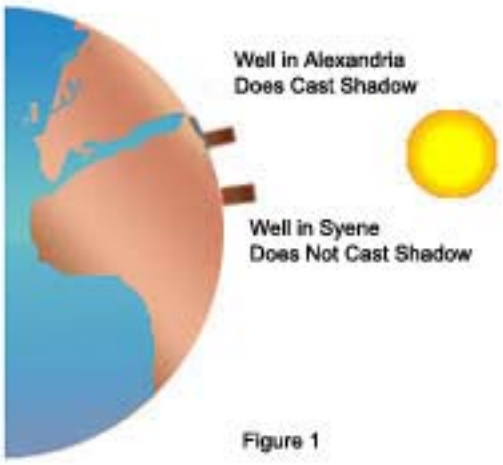

Figure 1

To determine the angle of the sun at Alexandria when it was directly overhead in Syene, Erastothenes used the information in Figure 2 and basic geometry. Using that information, the circumference of the earth can be determined, assuming it is a sphere, using the formula below Figure 2.

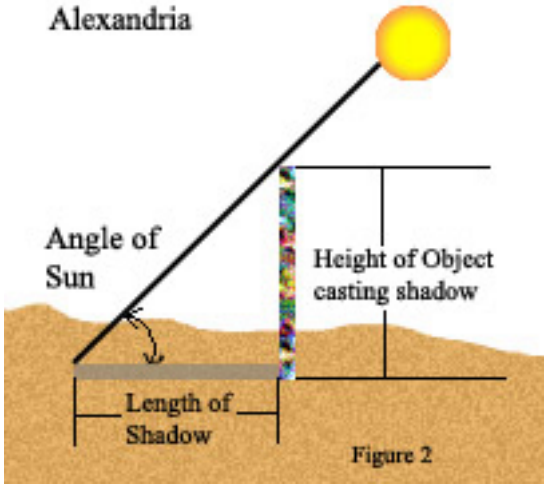

Figure 2

$$\frac{\text{Difference in Angles to the Sun}}{360 \text{ Degrees}} = \frac{\text{N/S distance}}{\text{Earth Circumference}}$$

Since Erastothenes had a pretty good estimate of the distance between Alexandria and Syene (787 Km or 489 miles), he was able to calculate the circumference of the Earth. His distance measurements were in units referred to as stadia. However, when this is converted over to miles, Erastothenes value, approximately 29,000 miles, was close to the actual value of 24,907 miles.

Shape of the Earth – An Ellipsoid!

With expansion of scientific knowledge and commerce, along with a desire to have accurate maps/charts, it was determined that a sphere is not the best mathematical model for the shape of the Earth. The best math model that we can make for the true shape of the Earth is a spheroid (or ellipsoid, the preferred term when referring to the Earth's shape). In a future article, the development of ellipsoids will be discussed.