Abu Simbel Solar Alignment

Abu Simbel was built by Pharaoh Rameses II between 1279 and 1213 B.C to celebrate his domination of Nubia, and his piety to the gods, principally Amun-Re, Ra-Horakhty and Ptah, as well as his own deification.

It is located 250 kilometers southeast of the city of Aswan. The original temple was positioned on the bank of the Nile, but it was raised up 300 meters by an international relocation project supported by UNESDO.

This mammoth engineering effort was undertaken between 1964 and 1968 to prevent the flooding of the temple by the rising waters of Lake Nasser caused by the new Aswan High Dam.

The satellite photo above, and on the next page, shows the entrance walkway ramp, and the area on the face of the cliff where the four giant statues of Ramses II are positioned. The interior of the temple extends to the left of the statuary and is hidden beneath the huge man-made berm to the left of the photograph. The 'Visitor Center' buildings can be seen as the three squares near the left-hand edge of the photo. The horizontal line in the upper right corner represents a distance of 50 meters, and the circle indicates the major compass directions clockwise from the top (north) as east, south and west.

The interior of the temple is inside the sandstone cliff in the form of a man-made cave cut out of the rock. It consists of a series of halls and rooms extending back a total of 56 meters (185 feet) from the entrance. As you walk to the rear of the temple you come to the Holiest of Holies located at the back wall, where you will find four statues of Ptah, Amun-Re, Ramses II and Ra-Harakhte. This temple is unique, since the sun shines directly on the Holiest of Holies two days a year: February 21, the king's birthday, and October 22, the date of his coronation. Because of the precession of the equinoxes, the current dates are one day later than the original dates for which the temple alignment was designed.

Note: Ancient alignments are defined in terms of the local azimuth and elevation system of position measurement. Measuring the angle clockwise from geographic North, the azimuth angle is 90 degrees due East, 180 degrees due South, 270 degrees due west and 0/360 degrees due North. Elevation is the angle above the horizon in degrees, with +90 degrees being the point directly over-head (Zenith).

Statues of Ramses II at the front of the temple. The doorway is 2 meters wide and is located 42 meters from the back wall of the temple. The seated statues are 20 meters tall.

Statues in the Holy of Hollies on the back wall of the temple. From left to right: Ptah, Amun-Ra, Ramses II and Ra Harakhte. Notice the sunlight illuminating the figures on the appointed dates.

Education Standards Satisfied by This Activity

(See Benchmarks for Science Literacy, Project 2061, AAAS)

1c – The Scientific Enterprise

G6-8 "Important contributions to the advancement of science, mathematics and technology have been made by different kinds of people, in different cultures, at different times.

G9-12 "The early Egyptian, Greek, Chinese, Hindu and Arabic cultures are responsible for many scientific and mathematical ideas and technological innovations.

2a – Patterns and Relationships

G9-12 "Although mathematics began long ago in practical problems, it soon focused on abstractions from the material world, and then on even more abstract relationships among these abstractions.

3A - Technology and Science:

G6-8 "Engineers, architects and others who engage in design and technology use scientific knowledge to solve practical problems. But they usually have to take human values and limitations into account as well.

4B – The Earth

G6-8 "Because the Earth turns daily on an axis that is tilted relative to the plane of Earth's yearly orbit around the sun, sunlight falls more intensely on different parts of the Earth during the year. The difference in heating produces the planet's seasons and weather patterns.

11B – Models

G3-5 "Geometric figures, diagrams, and maps can be used to represent objects, events and processes in the real world although such representations can never be exact in every detail.

Problem 1 - What is the scale of the satellite photo in meters per millimeter if the black bar in the upper right-hand corner is 20 meters long?

Problem 2 - On the dates of the solar alignment for Ramses II in 1240 BC, the location of the sun on the horizon was at azimuth 97 degrees. Locate the entrance doorway between the four statues of Ramses II on the satellite photo (cross near center of photo), and draw a line from the right to left-hand edges of the photo at the proper azimuth angle. If you are standing inside the doorway (towards left-hand side of picture) along this line, what will you see?

Problem 3 - The Holy of Holies is located 42 meters from the 4-meter wide entrance doorway. Where along the alignment axis line is the back wall of the temple? Draw a line at this location that is parallel to the front face of the temple, and measures 4 meters in length to match the four statues.

Problem 4 - On the same scale, draw the width of the 4-meter wide entrance doorway to the temple. In order for the sunlight to illuminate the Holy of Holies it must pass through the narrow slot of the front doorway as viewed from the location of the Holy of Holies. Draw two additional lines that represent the limits of the solar rays passing through the doorway, and measure the azimuth angles.

Problem 5 - Because the rotation axis of Earth precesses 360 degrees every 26,000 years, the location of the sun on the horizon on the same day of the year at Abu Simbel will move about 2.5 degree southward along the horizon every 2,000 years. If the azimuth angle on October 22, 2010 is 102 degrees, by what year will the sunlight no longer only fall on the back wall on October 22?

Problem 1 - Answer; Using a millimeter ruler, the horizontal bar is about 21 mm long and represents 20 meters so the scale is **1 meter/mm**.

Problem 2 - Answer: See drawing below. On the appointed dates you will see the disk of the sun rise on the horizon and the light will reach to your location inside the temple.

Problem 3 - Answer: See drawing below.

Problem 4 - Answer: See drawing below. The angles measured with a protractor are at azimuths of 93 degrees and 102 degrees.

Problem 5 - Answer: Students may measure the angle as 102 or 103 degrees depending on the accuracy of their drawing. In the extreme case where the angle is 103 degrees, this corresponds to 1.0/2.5 x 2000 years = 800 years of precession or a limiting year of 2810 AD. So in 2010 we are very close to the monument not 'working' for October 22, and in fact the date when the event occurs is moving one day later towards October 23.