# Probing Question: How were the Egyptian pyramids built?

March 27 2008

Pyramids at Giza. Photo: Diana Chaytor

The Aztecs, Mayans and ancient Egyptians were three very different civilizations with one very large similarity: pyramids. However, of these three ancient cultures, the Egyptians set the standard for what most people recognize as classic pyramid design: massive monuments with a square base and four smooth-sided triangular sides, rising to a point. The Aztecs and Mayans built their pyramids with tiered steps and a flat top.

The ancient Egyptians probably chose that distinctive form for their pharaohs' tombs because of their solar religion, explained Donald Redford, professor of Classics and ancient Mediterranean studies at Penn State. The Egyptian sun god Ra, considered the father of all pharaohs, was said to have created himself from a pyramid-shaped mound of earth before creating all other gods. The pyramid's shape is thought to have symbolized the sun's rays.

According to Redford, "The Egyptians began using the pyramid form shortly after 2700 B.C., and the great heyday of constructing them for royalty extended for about a thousand years, until about 1700 B.C." The first pyramid was built by King Djoser during Egypt's Third Dynasty. His architect, Imohtep, created a step pyramid by stacking six mastabas, rectangular buildings of the sort in which earlier kings had been buried. The largest and most well-known pyramids in Egypt are the Pyramids at Giza, including the Great Pyramid of Giza designed for Pharaoh Khufu.

For centuries, people have theorized how the great pyramids were built. Some have suggested that they must have been constructed by extraterrestrials, while others believe the Egyptians possessed a technology that has been lost through the ages.

But the process of building pyramids, while complicated, was not as colossal an undertaking as many of us believe, Redford says. Estimates suggest that between 20,000 and 30,000 laborers were needed to build the Great Pyramid at Giza in less than 23 years. By comparison, Notre Dame Cathedral in Paris took almost 200 years to complete.

According to Redford, pharaohs traditionally began building their pyramids as soon as they took the throne. The pharaoh would first establish a committee composed of an overseer of construction, a chief engineer and an architect. The pyramids were usually placed on the western side of the Nile because the pharaoh's soul was meant to join with the sun disc during its descent before continuing with the sun in its eternal round. Added Redford, the two deciding factors when choosing a building site were its orientation to the western horizon where the sun set and the proximity to Memphis, the central city of ancient Egypt.

The cores of the pyramids were often composed of local limestone, said Redford. Finer quality limestone composed the outer layer of the pyramids, giving them a white sheen that could be seen from miles away.

The capstone was usually made of granite, basalt, or another very hard stone and could be plated with gold, silver or electrum, an alloy of gold and silver, and would also be highly reflective in the bright sun.

Said Redford, the image most people have of slaves being forced to build the pyramids against their will is incorrect. "The concept of slavery is a very complicated problem in ancient Egypt," he noted, "because the legal aspects of indentured servitude and slavery were very complicated." The peasants who worked on the pyramids were given tax breaks and were taken to 'pyramid cities' where they were given shelter, food and clothing, he noted.

According to Redford, ancient Egyptian quarrying methods -- the processes for cutting and removing stone -- are still being studied. Scholars have found evidence that copper chisels were using for quarrying sandstone and limestone, for example, but harder stones such as granite and diorite would have required stronger materials, said Redford. Dolerite, a hard, black igneous rock, was used in the quarries of Aswan to remove granite.

During excavation, massive dolerite "pounders" were used to pulverize the stone around the edge of the granite block that needed to be extracted. According to Redford, 60 to 70 men would pound out the stone. At the bottom, they rammed wooden pegs into slots they had cut, and filled the slots with water. The pegs would expand, splitting the stone, and the block was then slid down onto a waiting boat.

Teams of oxen or manpower were used to drag the stones on a prepared slipway that was lubricated with oil. Said Redford, a scene from a 19th century B.C. tomb in Middle Egypt depicts "an alabaster statue 20 feet high pulled by 173 men on four ropes with a man lubricating the slipway as the pulling went on."

Once the stones were at the construction site, ramps were built to get them into place on the pyramid, said Redford. These ramps were made of mud brick and coated with chips of plaster to harden the surface. "If they consistently raised the ramp course by course as the teams dragged their blocks up, they could have gotten them into place fairly easily," he noted. At least one such ramp still exists, he said.

When answering to skepticism about how such heavy stones could have been moved without machinery, Redford says, "I usually show the skeptic a picture of 20 of my workers at an archaeological dig site pulling up a two-and-a-half ton granite block." He added, "I know it's possible because I was on the ropes too."

Source: By Marissa McCauley, Research/Penn State