Radiocarbon Testing Challenges Our Understanding of Ancient Hawaiian Architecture

An aerial view of a large war temple (Loaloa) on Maui.

Courtesy Michael Kolb and Northern Illinois University

The development of monumental architecture and social complexity on the Hawaiian island of Maui occurred over a span of at least 500 years, according to the most detailed study to date on the antiquity of the island's extensive temple system. The findings, in the August 2007 issue of *Current Anthropology*, challenge previous conceptions of ancient Hawaiian civilization by identifying cycles of temple construction that coincide with politically charged periods of warfare and island consolidation.

"Because the islands are relatively isolated from the rest of the world, the development of monumental architecture and complex society in Hawai'i is of keen interest to archaeologists," writes Michael Kolb (Northern Illinois University), who spent more than a decade locating and excavating temple sites. "In many ways, Maui represents an excellent test case for state development. Its monumental architecture is directly linked to economic, political, and ritual development, not unlike the most famous early civilizations, such as the Maya or ancient Egyptians."
Kolb conducted radiocarbon-dating* analyses on samples from forty ruins on the island of Maui, including several newly discovered temples. The radiocarbon dates indicate the earliest temples were built in the 13th century, with construction continuing into the early 19th century. Prior research had indicated that Maui's temples, known as heiau, were built within a span of decades near the turn of the 17th century.

Kolb's study also identifies an important shift in temple construction from open-air temples used for ancestral worship to enclosed, more elaborate temples used for sacrificial offerings to war gods. Large temples often covered more area than a football field and stood 40 feet in height.

"The Hawaiian civilization did not use ceramics, which is typically why radiocarbon dating is relied upon by scientists," says Kolb. "Before a temple was built, the land would be set ablaze to clear it from vegetation, leaving behind charcoal remains. We also were able to gather samples for dating from the sites of ancient ovens and bonfires."

The ancient people of Maui stacked lava rocks to form the foundation of the platform temples, often built on the faces of cliffs or other high points on the island. The more elaborate, terraced temples were adorned with altars, oracle towers, offering pits, and god or ancestral images carved from wood or stone.

"Oftentimes, in a show of economic might, a conquering chief would remodel, build additions to, and re-dedicate a rival's temples," explains Kolb. "Many of the early structures were modified or new ones were built with enclosures on top. Access was limited to reward loyal constituents, and sacrificial worship became more of a focus."

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*What is radiocarbon dating? Carbon is what’s in your pencil (graphite) in your barbecue (coal) and in your jewelry (diamond). Carbon is abundant on Earth in various forms and scientists can figure out how old carbonaceous materials are by a radiometric dating method that uses the naturally occurring isotope carbon-14 (^{14}C) to determine age up to about 60,000 years!
**BONUS READING: More About Radiocarbon Dating**

The technique of radiocarbon dating was discovered by Willard Libby and his colleagues in 1949 during his tenure as a professor at the University of Chicago. Libby estimated that the steady state radioactivity concentration of exchangeable carbon-14 would be about 14 disintegrations per minute (dpm) per gram. In 1960, he was awarded the Nobel Prize in chemistry for this work.

One of the frequent uses of the technique is to date organic remains from archaeological sites. Plants fix atmospheric carbon during photosynthesis, so the level of C14 in living plants and animals equals the level of C14 in the atmosphere.

**Radiometric dating** (often called **radioactive dating**) is a technique used to date materials, based on a comparison between the observed abundance of particular naturally occurring radioactive isotopes and their known decay rates.[1] It is the principal source of information about the absolute age of rocks and other geological features, including the age of the Earth itself. Among the best-known techniques are potassium-argon dating and uranium-lead dating. By allowing the establishment of geological timescales, it provides a significant source of information about the dates of fossils and the deduced rates of evolutionary change. Radiometric dating is also used to date archaeological remains and ancient artifacts, the best known technique in this field being radiocarbon dating.

Raw, uncalibrated, radiocarbon ages are usually reported in **radiocarbon years** "Before Present" (BP), "Present" being defined as AD 1950. Such raw ages can be calibrated to give calendar dates.

See isotope markings on this photographic plate (bottom right: isotopes of neon-20, neon-22, & carbon compounds)
**BONUS READING: More About Carbon & Allotropy**

The structure of eight *allotropes* of carbon are shown in this diagram:

- a) Diamond
- b) graphite
- c) Ionsdaleite
- d) C60
- e) C540
- f) C70
- g) amorphous carbon
- h) a carbon nanotube

**Allotropy** is a behavior exhibited by certain chemical elements: these elements can exist in two or more different forms, known as *allotropes* of that element. In each different allotrope, the element's atoms are bonded together in a different manner.

For example, the element carbon has two common allotropes: diamond, where the carbon atoms are bonded together in a **tetrahedral** lattice arrangement, and graphite, where the carbon atoms are bonded together in sheets of a **hexagonal** lattice.

Note that allotropy refers only to different forms of an element within the same state of matter (i.e. different solid, liquid or gas) - the changes of state between solid, liquid and gas are not considered allotropy. For some elements, allotropes have different molecular formulae which persist in different phases - for example, the two allotropes of oxygen (dioxygen, $O_2$ and ozone, $O_3$), can both exist in the solid, liquid and gaseous states. Conversely, some elements do not maintain distinct allotropes in different phases: e.g. phosphorus has numerous solid allotropes, which all revert to the same $P_4$ form when melted to the liquid state.