

of domesticated plants and animals: Grains like sorghum and millet made their way from Africa to India; zebu cattle went from India to Africa; and cinnamon and nutmeg moved from South Asia all the way to Israel and Egypt—although it is unclear who carried this bounty from continent to continent, and how.

Now, a second phase of international trade, in the early centuries B.C.E., is coming to light in the eastern half of the ocean. In this period, India and China were urbanizing but Southeast Asia was long considered a rural backwater until its first empires arose, such as the Khmer empire based at Angkor Wat. Now, archaeologists are discovering that by 400 B.C.E., Southeast Asians were making iron, supporting an elite, and building large moated settlements of their own design, says Charles Higham of the University of Otago, Dunedin, in New

Zealand, who has excavated extensively in Thailand and Cambodia.

This new Southeast Asian elite would have prized luxury goods—and new finds suggest that trade with distant north India helped provide them. Between 2005 and 2009, a French-Thai expedition uncovered what may be the oldest known city in Southeast Asia, at the narrowest point of the Malay Peninsula that separates the Indian Ocean from the South China Sea. The site of Khao Sam Kaeo was an early and important trading link between India and Southeast Asia, argues Bérénice Bellina-Pryce, an archaeologist from the French national research agency CNRS in Paris who led the dig.

Located 500 kilometers south of Bangkok, Khao Sam Kaeo is now a remote swamp. But millennia ago, it was a convenient point to unload goods from the Indian Ocean for overland transport to

Southeast Asia (see map, p. 1441), avoiding a longer voyage through the treacherous, pirate-plagued Strait of Malacca to the south. The dig revealed that from the 4th century B.C.E. to the 1st century B.C.E., Khao Sam Kaeo was a sprawling city of walled neighborhoods surrounded by a ditch-and-palisade rampart. The finding was so unexpected that “it took me years to convince colleagues that we had an early form of urbanization,” Bellina-Pryce says. Later cosmopolitan coastal towns in this region probably resembled Khao Sam Kaeo.

Working in dense forest and beset by looters, the team found metal vessels and stone and glass beads linking the site to India to the west and to Vietnam and China to the east. Bronze and iron workers at the site used copper alloys similar to those in Vietnam and China. But the beads, although made locally, were crafted using

Drawing a bead on trade

By Andrew Lawler

In a small laboratory tucked into the Field Museum in Chicago, Illinois, Laure Dussubieux carefully positions a tiny bead so that a laser can drill a microscopic pit into its surface, releasing a puff of gas. A mass spectrometer then reads the gas's composition, including the trace elements. The result is a unique signature that often can reveal how, where, and even when the glass was formed, Dussubieux explains. And that has turned humble glass beads into tools for tracing long-lost trade routes in the Indian Ocean (see main story).

“I think it's pretty great that you can take a simple glass bead, shoot a laser at it, crunch some numbers, and then get the recipe used to make the glass,” says Alison Carter, an archaeologist at the University of Wisconsin, Madison, and one of many researchers who show up regularly at Dussubieux's door with their own colorful bits of glass.

Around the vast Indian Ocean, peoples spoke different languages, ate different foods, and worshiped different gods. But they shared a love of glass beads, which typically were strung together to make colorful bracelets and necklaces. Enormous effort and skill went into making huge numbers of baubles as small as 3 millimeters in diameter in a dazzling array of colors. Difficult to date and organize into types, the artifacts were long neglected by archaeologists.

Then, in the 1990s, archaeologist Bernard Gratuze of the French national research agency CNRS in Orléans began to pioneer bead analysis using lasers and a mass spectrometer; Dussubieux learned the technique as a Ph.D. student in his lab. Beads were often made locally of raw glass ingots that had been shipped great distances, and the new technique made it possible to trace the glass to its origin, revealing shipping and trade routes.



Indo-Pacific beads offer clues to ancient trading patterns.

For example, bead studies have shown that a glass formula using mineral soda appears to have originated around the 5th century B.C.E. in the Ganges plain of northern India and then spread south and east. When Dussubieux analyzed about 200 beads excavated at Khao Sam Kaeo, which emerged as a trading city on the Malay Peninsula beginning in the 4th century B.C.E., she found that many were made

of this soda-rich glass. Thus, the raw glass was likely made in India and shipped more than 2000 kilometers east.

In a study of Cambodian beads, Carter discovered that 1st century C.E. beads from the southeast of the country were made using potash—an indigenous Cambodian method—whereas beads in the northwest consisted of mineral soda glass from India. In later centuries, however, soda glass spread to southeastern Cambodia, perhaps a sign of rising Indian influence.

Across the Indian Ocean, Marilee Wood of the University of the Witwatersrand in Johannesburg, South Africa, is using bead analysis to track trade routes along the southern coast of East Africa. Changing bead types reveal African ties to the Middle East starting around the 7th century C.E., followed by trade with distant Sumatra and then with India around 1000 C.E. “We have early glass coming from Southeast Asia,” she says. “This is a very different pattern than you find in the north” coast, where Middle Eastern and Indian glass predominates.

Carter, like many of her colleagues, praises Dussubieux for her analyses and patient work training others to read beads. She's “a walking database of glass types,” Carter says. “Combined with the body of work from Laure and others, the glass bead can be tied into a whole network of ancient glass production and trade.” ■