When Harold Dibble was reopening excavations at the Grotte des Contrebandiers (Smuggler’s Cave) in Morocco a few years ago, he looked for experts to help him figure out when prehistoric humans had occupied the cave, which is a key site for understanding the spread of Homo sapiens. Dibble knew our species had been there more than 50,000 years ago—beyond the practical limit of radiocarbon dating. So he recruited two dating aces from the University of Wollongong in Australia, Zenobia Jacobs and Richard Roberts, experts in the technique of optically stimulated luminescence (OSL) dating. That method determines how long buried sand grains have been hidden from sunlight and can peer back 200,000 or more years in time.

Dibble had never met Roberts and Jacobs, but he invited them to Contrebandiers. In contrast to radiocarbon dating labs that simply process samples taken by others, the pair spent 2 weeks at the site, discussing the stratigraphy and the research questions, and working at night so their samples wouldn’t be spoiled by exposure to sunlight. “I was impressed with how totally professional they were,” Dibble says. They were so professional that more than a week passed before Dibble spotted Roberts with his arm around Jacobs and realized that they were romantically involved.

Jacobs and Roberts, who married last December—“You can call us the double daters,” Roberts says—eventually dated a skull at Contrebandiers to an impressive 100,000 years ago (Science, 7 January, p. 20). Today they, and the powerful method they wield (see sidebar), are much in demand to help settle a wide range of questions in archaeology. “[Their] laboratory is widely acknowledged to be the world’s premier [OSL dating] facility,” says dating expert Thomas Higham of the University of Oxford in the United Kingdom.

Radiocarbon has long been the leading dating method in archaeology, but it requires organic material such as charcoal or bone. And many of today’s hottest research questions center on events that took place more
than 50,000 years ago: When did modern humans begin to use symbols? When, and along what routes, did they leave Africa? Jacobs and Roberts are putting time stamps on some of these key events in modern human evolution, whose dates have long been uncertain. In the process, they are “transforming our understanding of the evolution of modern human behavior and the dispersal of modern humans out of Africa,” says Oxford archaeologist Michael Petraglia, who is working with them on sites in India and Arabia (Science, 5 March 2010, p. 1187).

**Coming together**

Although the pair now work as a team, Jacobs, 34, and Roberts, 51, come from very different backgrounds and followed divergent career paths. And yet they sometimes ended up at the same place at different times.

Roberts, universally called Bert and known for his sense of humor, is a lanky Englishman who now also has Australian nationality. He grew up in the suburbs of London amid the traces of Roman forts, “surrounded by old things,” he says. But before turning to archaeology, he began as a geologist.

While doing his Ph.D. work at the University of Wollongong on the effects of uranium mining on a creek in the Northern Territories of Australia, Roberts turned to thermoluminescence (TL) dating to find out how quickly the landscape near the mine was changing. Buried sediments absorb energy from background radiation until they are exposed to heat or light. TL dating uses heat to release that stored energy, which provides a measure of how long the sediments have been buried. Roberts soon realized that TL could date archaeological sites too old for radiocarbon dating. With colleagues, he roamed across Australia, for the first time applying both TL and the then-new OSL technique—which uses laser light instead of heat to release the stored energy—to ancient human sites. “It was my first introduction to archaeology, and I’ve never dug my way out of it since,” he says.

Roberts began to work to improve the OSL method with Andrew Murray, now director of the Nordic Centre for Luminescence Research in Roskilde, Denmark. Rather than taking the measure of an entire sample and so averaging the grains within it, Roberts and Murray focused on determining when single grains had last been exposed to light.

With the single-grain method, Roberts demonstrated that Australia had first been occupied by modern humans between 45,000

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and 50,000 years ago, in contrast to earlier claims of up to 60,000 years ago. These dates, which could not have been achieved using radiocarbon, also suggest that humans were largely responsible for the extinction of Australia’s giant birds and supersized kangaroos, which disappeared about 40,000 years ago (Science, 22 January 2010, p. 420).

While Roberts was working to improve OSL dating, Jacobs was a student in South Africa just discovering the technique. She grew up speaking Afrikaans, the daughter of a minister in a small mining town in Kruger National Park. As a child, Jacobs says, “life was all about nature.” She explored early iron smelting furnaces that dotted the landscape. “That made me quite curious about how old things were and where things came from,” she says.

Jacobs, who spoke no English until she spent a year in Australia on an exchange program at age 17, was taught by leading archaeologists and dating experts. She says she “fell in love with archaeology from the first class” in South Africa. As an undergraduate, Jacobs began exploring several methods to date the South African site of Blombos, famed for its ancient beads and etched ochre, possibly the earliest known art. For her Ph.D. work on Blombos and other sites, she teamed up with OSL pioneer Ann Wintle of Aberystwyth University in the United Kingdom, where Roberts had been an undergraduate many years earlier. Jacobs “doesn’t suffer fools gladly and has very high standards that she applies to herself and to other people,” Wintle says.

Jacobs found herself grappling with a key question in human evolution: when symbolic behavior began. Some researchers had argued that symbolism, such as art and jewelry, made its first appearance in Europe 50,000 years ago or later. But others countered that symbolism had its roots much earlier in Africa. Jacobs used OSL to date the layers containing ochre and beads at Blombos, using both single and multigrain techniques. She found that these apparently symbolic objects were created at least 75,000 years ago (Science, 11 January 2002, p. 247), settling the debate for a majority of researchers. Her widely cited study “revolutionized our understanding,” says archaeologist Curtis Marean of Arizona State University, Tempe.

Jacobs and Roberts first learned about each other through their research. Roberts had reviewed her papers; she knew him from afar as an OSL dating pioneer. Soon after they finally met, in 2004, Roberts began recruiting her to the University of Wollongong, where he had moved permanently in 2001. In 2006, Jacobs came to Wollongong, and not long afterward the daters began to date. Jacobs and Roberts are each other’s “perfect partners,” Higham says.

More than technicians
Jacobs and Roberts now work as a close-knit team from their lab in Wollongong. One of them usually does the fieldwork for a given project—Roberts in Australia, India, and Arabia; Jacobs in Africa and Europe—but lab analysis is a fully joint operation. Jacobs has taken the lead in projects designed to improve OSL, for example in decisions about which grains are best for single-grain dating and which should be rejected because they may give erroneous results. She also serves as the lab’s manager, leaving her imprint with sternly worded signs at each workstation spelling out the dos and don’ts.

Not content to be dating technicians, the pair is pursuing their own research agenda and often offers to date sites with their own funding. They have received more than $7 million from the Australian Research Council in the past decade. “Right from the research design stage, we had discussions about how new dating results would be integrated into our project,” says Petraglia, whose team is tracing human migrations from Africa into southern Asia.

For example, in a key 2008 Science paper (31 October 2008, p. 733), the pair pinpointed dates for two innovative stone tool technologies found across southern Africa. Known as the Still Bay and the Howieson’s Poort, these advanced toolkits, including tools hafted to spears or arrows, were thought to be associated with symbolic behavior. But researchers weren’t sure about how long each lasted, the relationship between them, or why they seemed to give way to less sophisticated stone tools soon afterward.

In a paper Higham calls “hugely important,” the pair was able to get very tight time resolution on these tools, showing that modern humans were simultaneously engaging in similar behavior across vast territorial expanses. This work also demonstrated one of the key advantages of single-grain OSL dating. “We can see if things are contemporaneous, or relatively older or younger,” Dibble says. “That is just as important as knowing their actual ages.”

Jacobs and Roberts showed that the Still Bay was extremely limited in time, between 71,000 and 72,000 years ago, while the Howieson’s Port lasted from 60,000 to 65,000 years ago. Thus the technologies did not overlap, and their appearances were not correlated with climate change, as some had thought. “OSL is key to our understanding of behavior” in this critical period, says archaeologist Lyn Wadley of the University of the Witwatersrand, Johannesburg, in South Africa. “Previously, we didn’t even know whether the Still Bay definitely came before the Howieson’s Poort.”

Roberts and Jacobs’s work so far has focused mostly on Africa, Asia, and Australia, but they have more plans for Europe, where limited OSL dating has been done. Working beyond radiocarbon’s limits, the pair will use the single-grain technique at both Neandertal and modern human sites in an attempt to pinpoint when sophisticated behaviors arose in each group. “They will get a resolution that otherwise would not be possible,” Dibble says.

Says Petraglia: “I feel fortunate to be associated with them. … Luminescence dating has the potential to transform our understanding of human evolution in these places, and Bert and Zenobia are at center stage in this work.”

–MICHAEL BALTER