ARCHAEOLOGY

Art on the move

Studies of stencils and paintings from prehistoric caves in Indonesia date the art to at least 39,900 years ago — around the same age as the earliest cave art previously known, 13,000 kilometres away in western Europe. SEE LETTER P.223

WIL ROEBROEKS

The Maros karst in Sulawesi, Indonesia, is a limestone area with many caves and a large body of rock art. This art was first reported in the 1950s, and it was long assumed to be less than 10,000 years old, because it was thought that rapid erosion rates in a tropical karst environment would prevent the survival of older cave paintings. In this issue, Aubert *et al.*[1] (page 223) actually date some of that art, and report that it is one of the oldest examples of cave art in the world. This spectacular finding suggests that the making of images on cave walls was already a widely shared practice 40,000 years ago.

Mineral-rich water trickling over cave walls can form thin layers of calcite containing trace amounts of uranium. The radioactive decay of uranium atoms acts like a clock, enabling dating of the calcite formations (also called speleothems) using the uranium–thorium dating method. In cases where calcite overlies cave paintings, dating its formation can yield a minimum age for the art.

In their study, Aubert and colleagues removed tiny samples from Maros rock-art panels using a rotary tool equipped with a diamond saw blade. The coralloid speleothems (known as cave popcorn) covering the art were less than 10 millimetres thick, and the samples were subsequently micro-excavated in the lab in 'spits' of less than 1 mm. This method, which proceeded from the exterior surface of the speleothem towards the pigment layer and sampled above, and sometimes also below, the pigment, yielded a robust minimum and in some cases a maximum age for the paintings.

The results were unexpected. One stencilled hand was painted at least 39,900 years ago, and images of a pig deer (babirusa) and a large, indeterminate animal, probably a pig, were created at least 35,400 and 35,700 years ago, respectively. These dates are in the age range of the earliest cave art found in the westernmost tip of Europe. There, comparable dating techniques applied to calcite overlying rock art in 11 caves in northern Spain established a minimum date of 40,800 years for a red disk from El Castillo, the oldest cave painting known so far[2]. A hand stencil from the *Panel de los Manos* at the same site yielded a minimum date of 37,300 years. A study[3] earlier this year claims to have identified an abstract pattern engraved by Neanderthals more than 39,000 years ago, in Gorham's Cave in Gibraltar. However, both the Neanderthal authorship (on the basis of its age) and the symbolic character of this 'rock art' have been questioned[4].

Figure 1 | Prehistoric paintings. Aubert *et al.*[1] find that the oldest-known cave art in the Maros cave in Sulawesi, Indonesia, is of comparable age — around 40,000 years old — to the previously oldest-known paintings by humans, from El Castillo cave in Spain. It is not clear whether rock art was already part of the cultural repertoire of modern humans colonizing Eurasia from Africa, or whether artistic ability arose independently in various regions. There is extensive evidence of occupation by modern humans in Oceania from around this time and somewhat longer ago (archaeological sites with dates to 40,000 years and earlier denoted by white dots; sites mentioned in the text denoted by red dots). Lower sea levels in this period (approximately −60 metres; shaded area) meant that several present-day islands were connected, but vast stretches of open sea still had to be crossed by humans colonizing the region. (Map based on data in ref. 20.)

The earliest figurative rock art from western Europe is a painted rhinoceros from the Chauvet Cave in France, radiocarbon dated to 32,410 ± 720 ^{14}C years before present[5], which is 35,300 to 38,827 calendar years ago[2] (although doubts have been raised[6] about whether the art is in fact this old). Rock fragments with traces of red paint from the Italian site of Fumane indicate that paintings were produced there between 36,000 and 41,000 years ago[7].

A rich corpus of rock art also exists at the other side of the spatial distribution of modern humans, in Australia. But although the first human occupation there goes back about 50,000 years, no rock art older than 30,000 years is known. Nevertheless, worn ochre crayons recovered from 50,000-year-old deposits in Arnhem Land, in northern Australia, show that some form of pigment use did occur there too, from the very first occupation onward[8].

For the moment, the bottom line is that

cave art was practised in Europe and in southeast Asia at about the same time, before 40,000 years ago. That by itself is an important observation. But how to interpret this long-distance 'contemporaneity' is unclear. Southeast Asia was already occupied by the extinct hominin species *Homo erectus* at least 1 million years ago, and modern humans (members of our own species originating in Africa) reached this area probably sometime before 50,000 years ago. The modern-human occupation history of southeast Asia and the continent Sahul, which existed during periods of lower sea levels in the Pleistocene epoch (around 2.5 million to 12,000 years ago) and is now New Guinea, Australia and other islands, testifies to the role of marine navigation over vast stretches of open sea in this colonization process[9] (Fig. 1).

Whether rock art was an integral part of the cultural repertoire of colonizing modern humans, from western Europe to southeast Asia and beyond, or whether such practices developed independently in various regions, is unknown. What is clear is that no figurative art is known from before the time of the initial expansion of *Homo sapiens* into Asia and across Europe — neither from earlier *H. sapiens* in Africa nor from their contemporaries in western Eurasia, the Neanderthals, who became extinct during the period of modern-human expansion out of Africa. The dating technique applied by Aubert *et al.* requires only minute amounts of calcite, and hence holds great potential for dating rock art worldwide, to shed light on when this art first appeared as well as on how it developed through time and space.

Aubert and colleagues' study underlines the great cultural–historical importance of the Maros area, which is under threat from large-scale limestone mining. Their findings also stress the great relevance of Asia, and especially southeast Asia, for the study of human evolution[10]. The huge Asian continent is the home of recent key finds, including a series of early *Homo* individuals at Dmanisi, Georgia, dating to between 1.7 million and 1.8 million years ago[11], and the mysterious Denisovans — members of a *Homo* species that are known only through their genetic signature[12]. The oldest-known *H. sapiens* genome was obtained from a 45,000-year-old femur, discovered at Ust-Ishi in Siberia[13]. Compared with Europe, Asia has seen little fieldwork, and new finds will keep on challenging what we think we know about human evolution. Even the evolution of the Neanderthals looks more and more like an Asian phenomenon[14,15], with Europe's large number of Neanderthal remains — known from a long history of intensive research — possibly reflecting repeated colonizations from central and western Asia[16].

Southeast Asia also harbours the type site of *H. erectus*, at Trinil, Java, and Sulawesi's neighbouring island, Borneo, contains the spectacular Greater Niah Cave, which has a record of human presence from about 50,000 years ago onward, including the first unambiguous fossil of a modern human in the area, a skull at least 40,000 years old[17]. Borneo also has a rich, but as-yet-undated, rock-art record, with some very striking similarities to the Maros paintings[18]. Finally, one of the most remarkable and least expected palaeoanthropological discoveries was made 400 kilometres south of the Maros area, on the island of Flores: here, the late Mike Morwood, one of the authors of the Maros cave-art study, discovered the skeleton of a puzzling diminutive hominin, presented 10 years ago as *Homo floresiensis*[19] and nicknamed 'the hobbit' — another illustration of the surprises that this region can offer. ■

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ULTRALUMINOUS X-RAY SOURCES

Small field with a large impact

The nature of ultraluminous X-ray astronomical sources has long been unclear. The latest observations of these rare systems provide some crucial clues, but still leave theorists scratching their heads. See Letters p.198 & p.202

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In the late 1970s, astronomers discovered objects that emit unusually bright X-rays[1]. Given their extreme X-ray luminosity, these ultraluminous X-ray sources were thought to contain black holes. However, the mass of the black holes powering such objects has been a topic of much debate. Two studies in this issue, by Motch *et al.*[2] (page 198) and Bachetti *et al.*[3] (page 202), together with two recent reports by Pasham *et al.*[4] and Liu *et al.*[5], are changing our views about these systems.

Most black holes are created during the violent deaths of massive stars. Although such stellar-mass black holes weigh about 3 to 100 times the mass of our Sun, they can be difficult to see. Their extreme gravitational pull attracts anything that strays too close, even light. So, to learn more about them, we must observe them indirectly, by studying the effect they have on their environment.

If the stellar-mass black hole is orbited by a companion star, we can study its effects on the star. The black hole can pull material from the star's wind and/or surface. As material falls in (accretes), forming an accretion disk, some of the material's gravitational potential energy is lost as light — mainly X-rays. Such X-ray binary systems (Fig. 1) contain not just a disk but also an optically thin (transparent) medium, which is thought to sit either above and below the disk (a corona) or between the disk and the black hole (a hot inner flow). As the rate at which material travels through the accretion disk changes, the geometry of the system, and so its accretion state, will change accordingly.

X-ray binaries can also contain neutron stars — the smaller cousins of stellar-mass black holes. Like stellar-mass black holes, neutron stars are born in violent star deaths, but they are lighter, weighing only around 1.4 solar masses. The gravitational pull of these systems is again very strong, drawing in material. But unlike black holes, light can escape from them, and we can see their surface.

Black holes also have much heavier cousins, which reside in the centres of galaxies. They are known as supermassive black holes, and weigh