metry is unconventional (as in the cuprates). However, measurements of the superconducting properties are greatly hampered by the difficulty of growing single crystals with the optimal water content; preparing crystals by electrochemical deintercalation may be the key (*8*).

As noted, the hole density in Na_xCoO_2 may be increased by reducing the Na content x. In principle, with maximum Na content ($x = 1$), there are no holes on the lattice. As the Na content is reduced, the holes increase in proportion until every lattice site is occupied at $x = 0$. Determining how the electronic properties vary with hole concentration is essential for understanding this material. Recent progress has allowed the phase diagram to be established in the range $^1/_4 < x < {}^3/_4$ (see the figure, right panel) (*5*). As known from earlier work (*3*, *6*), the interval $x < 0.4$ includes the superconducting phase (with water intercalation), whereas the region near $x = {}^2/_3$ harbors the Curie-Weiss metal described above. The different hole densities in the two phases are confirmed by Fermi surface measurements with photoemission spectroscopy (*10*). Do these two distinct phases evolve smoothly into each other? The phase diagram reveals that the answer is no. Unexpectedly, a new state, occupying a strip centered at $x = {}^1/_2$, rises like a firewall between them. In this state, the material is a very poor electrical conductor. Apparently, with half of the sites occupied by holes, the system has found a new way to accommodate both the strong Coulomb forces and geometric frustration by firmly localizing the holes (so they lose their ability to carry a current). The mechanism for the formation of this "charge-ordered" insulating phase is currently an open issue. Finally, for $x > {}^3/_4$ there are hints that the material attains very weak magnetic ordering [a spin density wave (SDW) metal, as shown in the figure] at low temperatures.

Since the discovery of cuprate superconductivity in 1986, researchers in condensed matter physics have increasingly turned to novel materials—notably manganates, ruthenates, and nickelates—in which strong electron-electron interactions prevail. As in Na_xCoO_2, the array of phenomena uncovered presents a major challenge to conventional ideas. Nonetheless, steady progress has occurred in the difficult task of incorporating strong electron interactions into the quantum theory of solids.

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ANTHROPOLOGY

Getting to Know *Homo erectus*

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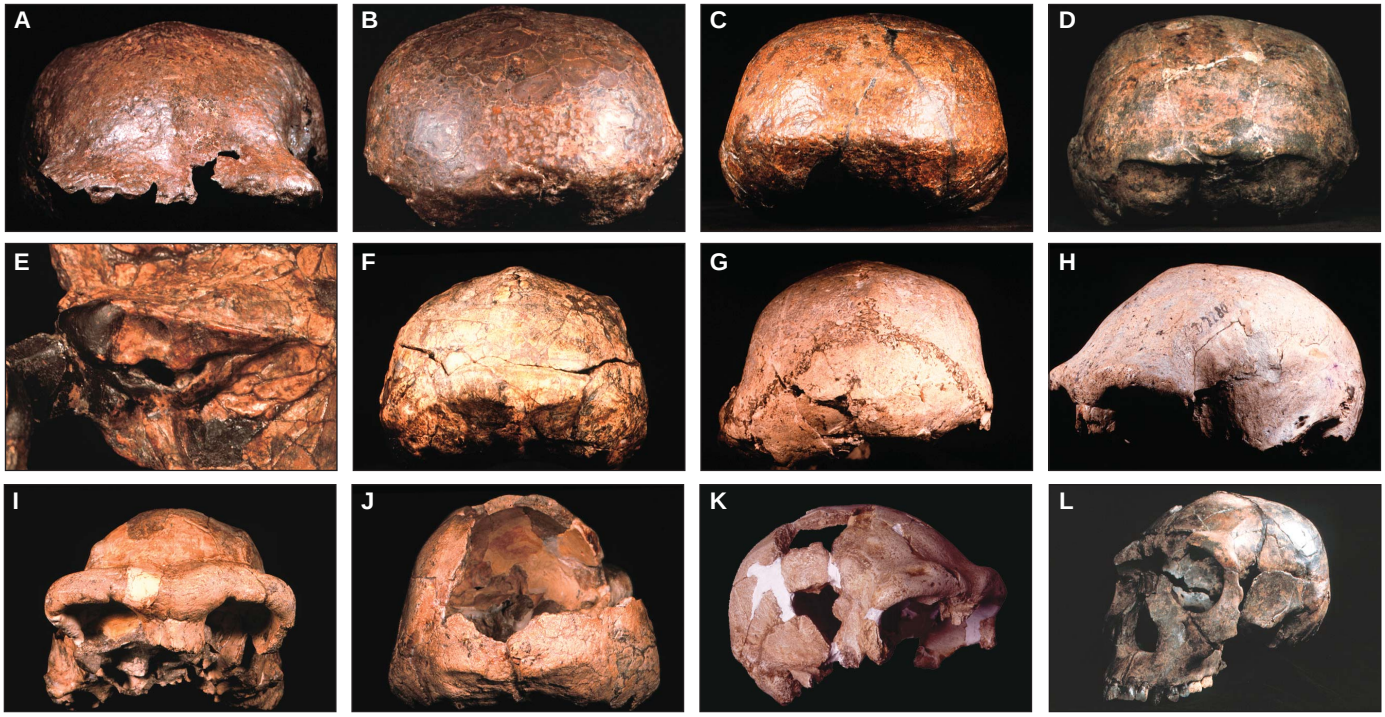
The period from 1 million to 500,000 years ago (~1 to 0.5 Ma) is well represented in the human fossil records of Europe and Asia. Sites containing such fossils include Ceprano, Italy (~0.9 to 0.8 Ma), the TD-6 level at Atapuerca's Gran Dolina, Spain (~0.78 Ma), Trinil, Indonesia (1 to 0.7 Ma), some parts of the Sangiran Dome, Indonesia (1.5 to 1 Ma), Lantian, China (~1 Ma), and probably Zhoukoudian, China (0.55 to 0.3 Ma). By contrast, Africa has been unusually uninformative about this part of human evolution. Three partial mandibles unearthed more than 50 years ago at Tighenif (Ternifine) in Algeria (~0.7 Ma) are similar in dental morphology to specimens from Gran Dolina (*1*), but the former are rarely mentioned in the literature. The question thus remained: Where are the African fossils? The recent discovery of the partial Daka skull (~1 Ma) at the Bouri site, Middle Awash, Ethiopia (*2*), provided part of the answer. On page 75 of this issue, Potts *et al*. (*3*) now report that the archaeologically and faunally rich site of Olorgesailie, Kenya, has divulged its first hominid fossils: a partial frontal and more fragmentary temporal bone dated 0.97 to 0.9 Ma. Like the Daka specimen, these fragments (KNM-OL 45500) were assigned to the species *Homo erectus*.

Potts *et al*. correctly assess the "*Homo erectus*" debate: "The entire sample of fossils from Africa, Asia, and Europe exhibits wide morphological variation that some researchers divide into multiple lineages and others place in a single, polytypic species." They opt for the latter hypothesis and conclude that "comparison of the KNM-OL 45500 with other crania . . . illustrates that metric and qualitative similarities cut across temporal and spatial groups of fossil specimens." Assuming that a vast array of specimens of differing morphologies constitute the same species, favorable comparisons between some of them in one or a few morphologies are expected, especially if primitive retentions and shared derived features are not sorted out. But this doesn't clarify the question, "What is *H. erectus*?" One is left primarily with the traditional approach to the genus *Homo*: *H. erectus* is not *H. habilis*, *H. heidelbergensis*, or *H. sapiens*, whatever they are. But there is a simple and systematically valid way in which one might unpack the morphological confusion: Begin with the original name-bearer of *H. erectus*, the type specimen, which was discovered in the late 19th century by Eugéne Dubois at Trinil.

The Trinil skull cap is distinctive in having a very low and long profile with a bluntly V-shaped occipital bulge (see the figure, panels A and B). In rear view, it is extraordinarily broad relative to its height. Its shelf-like, laterally flaring, and apparently rather thin brow ridges flow back smoothly into a gently sloping frontal plane. Near the foot of this rise, in the midline, is a pair of depressions that delineate between them an anteroposteriorly oriented "keel-like" structure. The sides of the brain case are minimally puffy. Specimens that share most of these features, but with a wide range of individual variation in their expression, come from Sangiran (panels C, D, and F). Some specimens of this substantial assemblage preserve a temporal bone (missing in Trinil) with unusual morphology: Unlike other mammals, this hominid's intracranial sigmoid sinuses were not single, but arborized prior to draining into the jugular veins (panel E). The Trinil/Sangiran sample also demonstrates that long-touted "*H. erectus*" features—very thick cranial bone, markedly puffy cranial side walls circumscribed by thick temporal lines, and pronounced midline keeling—are only variably expressed, if at all. Only the chunky Sangiran 4 specimen approaches this description (*4*) (panel F).

Do we see any of the consistent Trinil/Sangiran *H. erectus* cranial features in other hominid fossils? Not in the Javanese Ngandong specimens (1 to 0.36 Ma), the Sambungmacan (1 to 0.2 Ma) or Ngawi (undated) specimens, or those from Zhoukoudian or any other Chinese site (Dali, Hexian, Jinniushan, Lantian, Maba,

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The skull beneath the skin. Various specimens attributed to *Homo erectus*. The Trinil fossils (the *H. erectus* type specimen) and the Sangiran fossils represent the same species and show a wide range of individual variation. Note the odd shape of Trinil and Sangiran rear profiles, variation between individuals, and differences between these specimens and various specimens from Africa and Eurasia (G–L). (**A** and **B**) Trinil skull cap (front and rear views). (**C**) Sangiran 2 (rear view). (**D**) Sangiran 12 (rear view). (**E**) Sangiran 4 (internal view of right petrosal bone, rear toward right; note number of grooves behind and across the bone, rather than a single, well-defined sigmoid sinus coursing behind). (**F**) Sangiran 4 (rear view). (**G**) Dmanisi D2282 (rear view). (**H**) Dmanisi D2280. (**I** and **J**) OH 9 (front and rear views). (**K**) Ceprano (three-quarter view). (**L**) KNM-WT 15000 (three-quarter view). Images not to scale.

Yunxian) (*5*). Intriguingly, the D2282 partial cranium from Dmanisi in the Republic of Georgia (~1.7 Ma) is *H. erectus*–like in its very broad and low rear profile (see the figure, panel G) and somewhat shelf-like brows, but it has a single sigmoid sinus, whereas the differently configured D2280 partial cranium (panel H) has a bifurcated sigmoid sinus (*6*). Perhaps they are related to *H. erectus*.

Trinil/Sangiran morphologies are also lacking in African specimens, even in OH 9 from Olduvai Gorge, Tanzania (1.5 to 1.4 Ma), perhaps this continent's premier example of *H. erectus*. In rear profile, OH 9 is tall and roundedly triangular (see the figure, panel J). Its brow ridges are tall, more or less horizontal, thickened laterally, confluent across a very bulbous and prominent midline glabellar region, delineated by a depression or sulcus behind, and extended laterally well beyond the sides of the brain case (*1*) (panel I). Like the "mythical" *H. erectus*, OH 9 is thick boned, its cranial side walls are puffy, and it bears some frontal keeling.

Although first allied to OH 9, the Daka specimen compares better with the Ceprano skull [originally allocated to the species *H. erectus*, but now is the holotype *H. cepransensis* (*7*)] (panel K). They both have tall upwardly arced brow ridges, each with a sulcus behind that tapers somewhat laterally, turns downward medially, and is separated in the midline by a low-set and sunken glabellar region. They have similarly accentuated temporal muscle scars on their sides that emerge high up behind the brows. In each, the posterior root of the cheek bone (zygomatic arch) is forwardly positioned, and the space in front (temporal fossa), through which the temporal muscle coursed, is short (*1*, *8*). In OH 9, the posterior zygomatic root lies far back and the temporal fossa is much longer.

Other African specimens often included in *H. erectus* come from Lake Turkana, Kenya: on the east, Koobi Fora (KNM-ER 3733 and 3883) and, on the west, Nariokotome (KNM-WT 15000) (panel L), collectively spanning ~1.78 to 1.50 Ma. None of these East African specimens share any of the noteworthy features of Trinil/Sangiran *H. erectus*, prompting some paleoanthropologists to allocate them to a different species, *H. ergaster* (*9*).

Does this exercise clarify the affinities of the new hominid fossil OL 45500? Not yet. But recognizing that "*Homo erectus*" may be more a historical accident than a biological reality might lead to a better understanding of the relationships not only of the Olorgesailie specimens, but also of those fossils whose morphology clearly exceeds the bounds of individual variation so well documented in the Trinil/Sangiran sample. In the meantime, OL 45500 should remind us that hominid systematics must be an endeavor of testing long-entrenched hypotheses, especially when those who turn to these hypotheses acknowledge them as being problematic.

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