infection each year.

Lance K. Gordon, one of the Connaught researchers, told SCIENCE NEWS that the experimental vaccine represents the first successful application of a "carrier-hapten" approach to vaccine development. The technique uses a part of the *Haemophilus* bacterium that would normally stimulate only a weak immune response (a "hapten") and links it to a potent immune system stimulant, or "carrier" — in this case a protein component of diphtheria toxoid. The resulting antibody response is rich in *Haemophilus*-specific "memory cells" that enable infants to mount an amplified attack against the bacteria. *— R. Weiss*

Stone Age site gets pushed back in time

More than 20 years ago, the potassium argon technique for calculating the age of ancient rocks revealed that early hominid sites at Olduvai Gorge in East Africa dated to 1.8 million years ago, a much older estimate than had generally been recognized. The same method, which depends on the decay of potassium's naturally radioactive isotope to the nonradioactive gas argon, now has significantly pushed back the age of another East African site containing remains of later hominid activity during the Stone Age.

Artifact-bearing layers of volcanic ash at the Olorgesailie river basin in Kenya were formerly estimated to be about 500,000 years old, but now are more accurately dated at 700,000 to 900,000 years old, report Bethany A. Bye of the University of Utah in Salt Lake City and her colleagues in the Sept. 17 NATURE.

Large numbers of stone hand-axes have been uncovered at Olorgesailie (SN: 4/25/87, p.264), which is considered a key site of the Stone Age Acheulean culture. The almond-shaped axes are the primary Acheulean remains. The Acheulean era ranged from about 1.4 million to 150,000 years ago, but within that expanse there are few well-dated points at which cultural change can be examined.

In addition to revising the age of artifact-rich portions of the Olorgesailie site, Bye and her co-workers found that lower layers of volcanic ash differ chemically from overlying layers that contain the abundant Acheulean remains. They suggest that the lower and upper layers were created by separate volcanic eruptions.

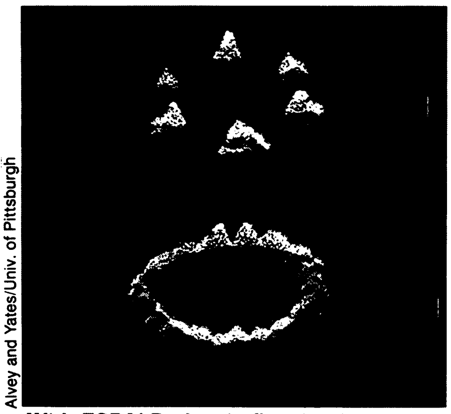
According to J.A.J. Gowlett of the University of Liverpool, England, writing in the same NATURE, the aging of Olorgesailie leaves researchers wondering whether they can confidently place any African hominid sites in the period between 700,000 and 300,000 years ago. *— B. Bower*

Going for a molecular spin

A surface is a busy molecular metropolis: Passing molecules restlessly jostle in and out of binding sites against the skyline of a material's atomic architecture.

Understanding how such molecules interact and bond at surfaces is key to designing a host of industrially important technologies, from semiconductor processing and catalytic and electrochemical techniques to corrosion control and the production of adhesives and lubricants.

One experimental technique that has helped scientists visualize the static bonding geometries between adsorbed and surface molecules is called ESDIAD, or electron stimulated desorption ion angular distribution. Now it has also enabled researchers to observe the rotation of adsorbed molecules, spinning like tops on a crystalline nickel surface. While spectroscopic techniques had suggested such molecular motions, says John T. Yates Jr. at the University of Pittsburgh, this is the first direct evidence of spinning molecular rotors.



Alvey and Yates/Univ. of Pittsburgh

With ESDIAD, the six fluorine ion beams indicate that at 85 kelvins, PF_3 molecules are sitting with their fluorine atoms sticking up in the air and are oriented in two possible positions over the underlying nickel crystal (top). As the temperature increases to 275 kelvins, the fluorine beams spread out into a ring, indicating that the molecules are spinning around their phosphorus hubs (bottom).

Yates expects that one possible spinoff of ESDIAD's ability to image rotational molecular motion will be the development of superior high-temperature lubricants; the technique can help scientists finger the molecular motions that turn well-ordered lubricants into disordered, more frictional substances at high temperatures.

In the ESDIAD technique, which was invented in 1974 at the National Bureau of Standards by Theodore E. Madey, Yates and a visiting Polish scientist, adsorbed molecules are bombarded with electrons. This breaks the molecular bonds, jettisoning positively charged pieces of the molecules. Because the ions are ejected along the original bond directions, their trajectories provide an image of the surface binding geometries.

ESDIAD shows, for example, that the phosphorus atom in the pyramidal molecule phosphorus trifluorine (PF_3) does all the clinging when the molecule is adsorbed onto the surface of a single crystal of nickel; emitted fluorine ions indicate that the molecule looks like an upside-down three-legged stool with fluorine atoms flung into the air directly above nickel atoms.

In an upcoming issue of the JOURNAL OF PHYSICAL CHEMISTRY, Yates, Pittsburgh's Mark D. Alvey and Kevin J. Uram at IBM in Yorktown Heights, N.Y., report that when they heat the PF_3-nickel surface, the fluorine-ion beams spread out into a ring, indicating that the fluorine-phosphorus bonds are spinning around the phosphorus seat of the PF_3 molecular stool.

By measuring the temperature at which molecules begin to spin and by modeling the rotation quantum mechanically, the researchers determined the amount of energy needed to initiate rotation. However, Yates says they do not yet understand the force that prevents spinning at low temperatures and that orients the PF_3 molecule in a very specific way relative to the nickel surface. He also notes that if the PF_3 molecules are closely packed on the surface, their rotation is strongly hindered by interactions between neighboring molecules, "somewhat like interlocking gears."

In another study, the researchers used ESDIAD to prove that similarly configured ammonia molecules also spin on nickel surfaces. Yates says he and others detected a ring pattern of ejected hydrogen ions from ammonia in the past, but they have not been able to cool their samples to temperatures low enough to halt the rotations. In their recent work, Yates's group instead used carbon monoxide and other molecules that form hydrogen bonds with ammonia to grab legs of the ammonia stools and make their rotations stop.

"So far we've only been able to do hydrogen bonding, but in principle we might be able to use these ideas to see stronger chemical bonds form between different species," says Yates. "This is really the beginning of the visualization of chemical reactions between two molecules sitting on a surface in a catalyst . . . where you can see molecule A beginning to snuggle up to molecule B and interacting with it." *— S. Weisburd*