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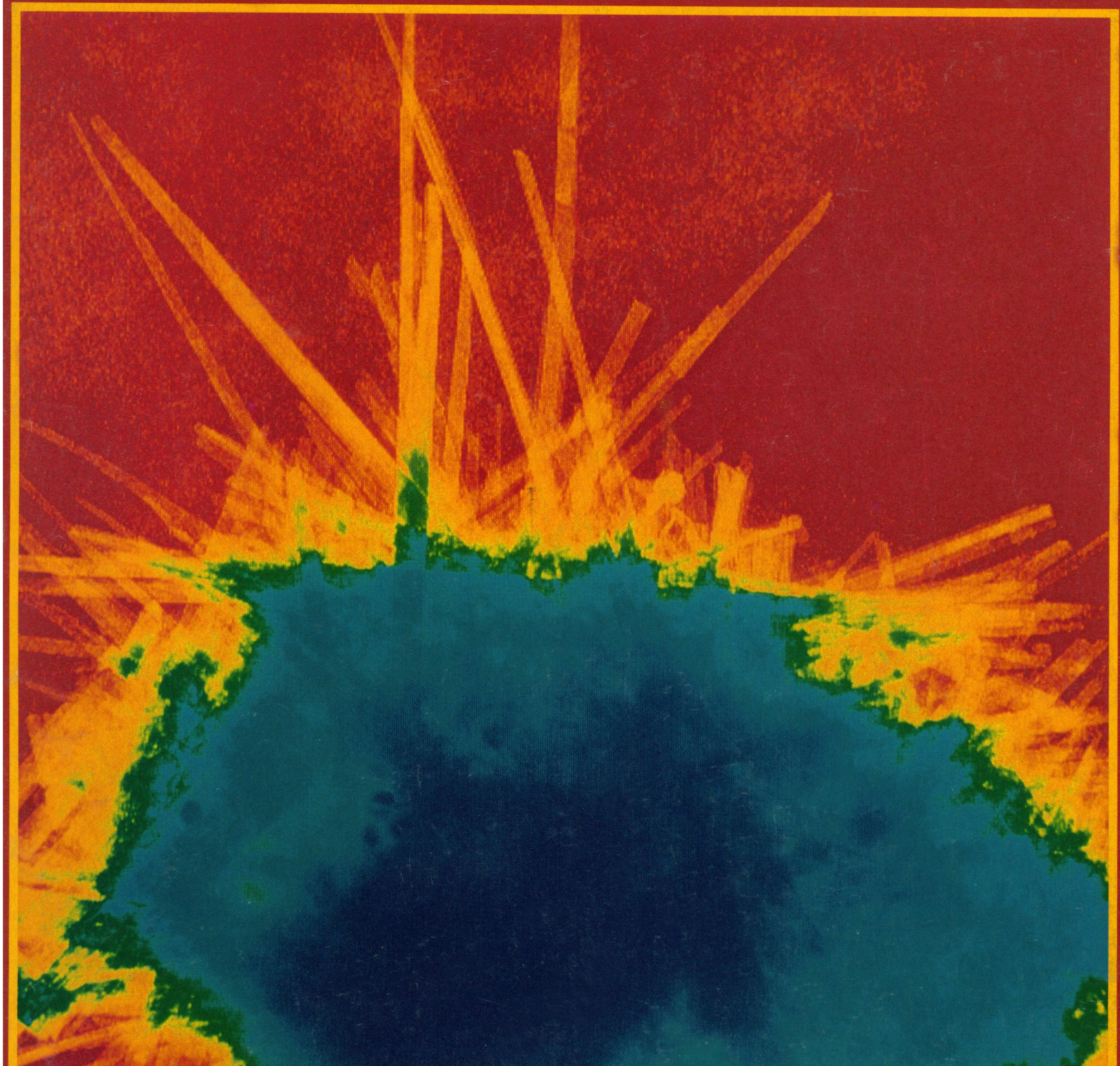

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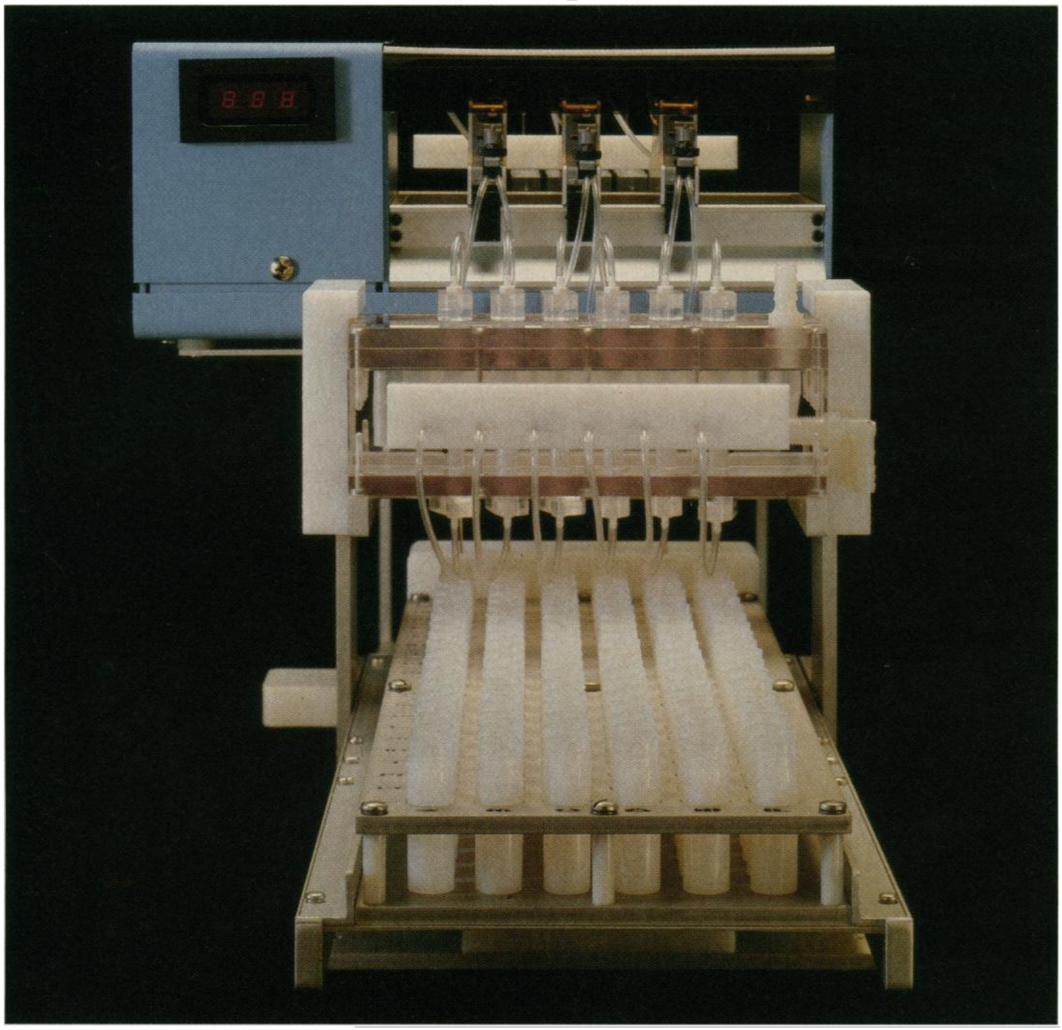

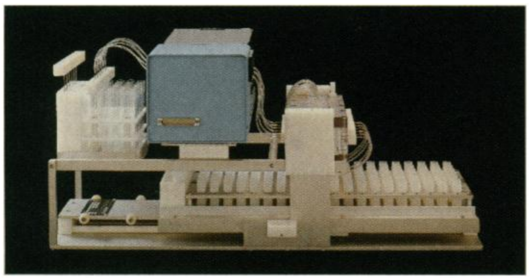

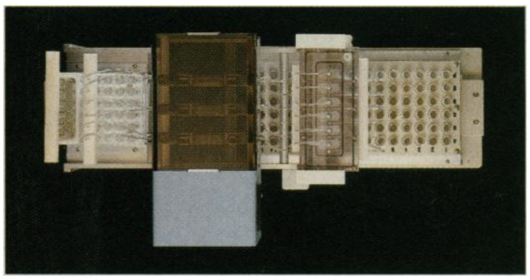

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COVER Pseudocolor transmission electron micrograph of fibrous, lath-shaped, diagenetic illite (less than 0.1-micrometer-size fraction) from the Repetto Formation, Santa Barbara Channel, California. Analysis of the sizes of illites and other clay minerals indicates that they coarsen by a process known as Ostwald ripening. See page 474. [Photo by Reed Glasmann, Unocal Corporation]

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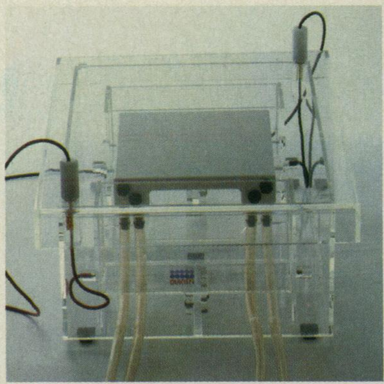

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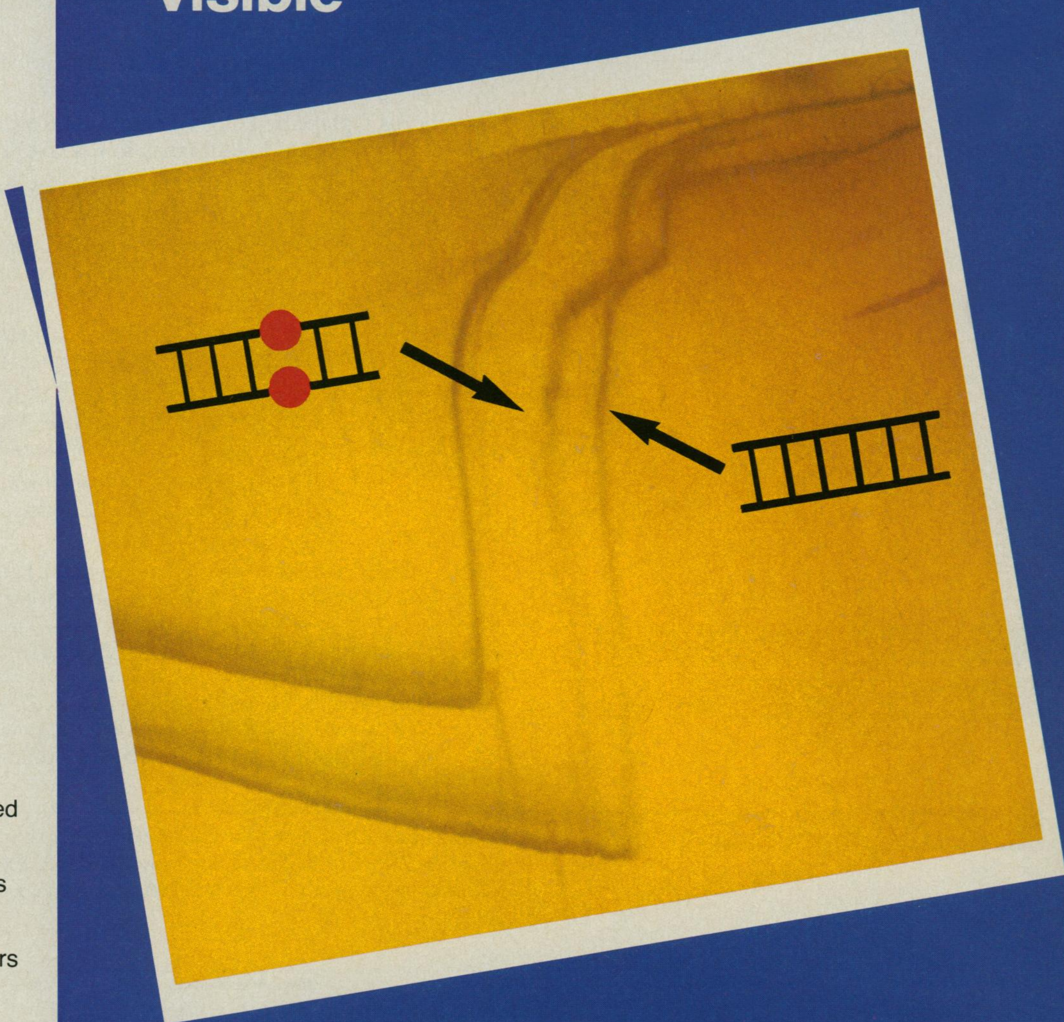

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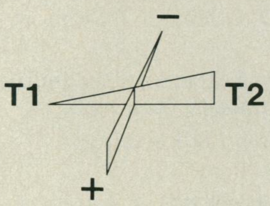

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This Week in SCIENCE

Making contact

FRICTION and wear occur when materials are brought into contact. The surfaces can stick together, change their shape, or fracture, depending on the material properties. Until the development of tunneling microscopes, the study of interfacial forces has had to rely on macroscopic measurements and continuum theories of elasticity and mechanics. Landman *et al.* have combined the high resolution of atomic-force microscopy with detailed computer simulations to observe processes such as contact formation, adhesion, and deformation (page 454). Molecular dynamics simulations were performed for a nickel tip interacting with a gold surface; the tip and the first eight atomic surface layers respond dynamically as the separation between sample and tip is changed. Forces between tip and surface were experimentally measured by means of a nickel probe mounted on a cantilever beam, and the deflection of the beam was monitored with a tunneling microscope. The combined studies revealed an atomic instability that caused the tip to jump to the surface, subsequent plastic flow during indentation, and formation of an atomically thin connective neck during separation.

A change of phase

WHAT happens at the atomic scale during phase changes such as melting is still not well understood, especially at high pressures and temperatures. Godwal *et al.* have used a high-pressure diamond cell to study the effects of pressure on the melting of lead as it is heated by an infrared laser beam (page 462). Quantum mechanical calculations were used to compare these results with those from previous experiments in which lead was melted by impact-generated shock waves. The Lindemann law, which states that a crystal should melt when the atomic lattice vibrates with sufficient amplitude, appears to agree with the experimental measurements over a wide range of pressures. Another type of phase change is a crystallographic transformation in which a material shifts from high to low symmetry as the temperature is decreased. Magnesium silicate perovskites are especially interesting because they may dominate the earth's lower mantle (between 670- and 2900-kilometer depth). Wang *et al.*, by taking electron micrographs of perovskites synthesized at high pressure and temperature, have found that when the crystals are returned to ambient conditions, they contain numerous "twins," or portions with mirror-image symmetry (page 468). From these structural studies, it may be possible to determine the crystalline arrangement of perovskites deep in the earth, which has important consequences for understanding the seismic and other physical properties of the lower mantle.

■ DAVID VOSS

Ancient mutualism

ECOLOGICAL models predict that mutually beneficial associations between species should develop less frequently than competitive interactions, such as occur between predator and prey. In fact, in the fossil record clear examples of mutualism are relatively rare. McKinney *et al.* (page 466) describe Early Devonian fossils (about 400 million years old) of the coral *Aulopora* and the bryozoan *Leioclema*. The growth of these organisms was limited by space; in isolation each formed encrustations that were 2 millimeters thick at most. Contact resulted in overgrowth of the coral by the bryozoan; arborlike "supercolonies" of the sparsely branched coral encrusted with bryozoan were formed that were about 20 centimeters in height and diameter. This structure provided access to nutrients in a normally unavailable part of the water column. The coral scaffolding probably reduced the amount of hard skeleton that the bryozoan had to secrete, and the water flows generated by the bryozoan may have directed food into the coral polyps. This finding bears out earlier predictions that mutualism would be favored by clonal species in severely limiting environments.

History in clay

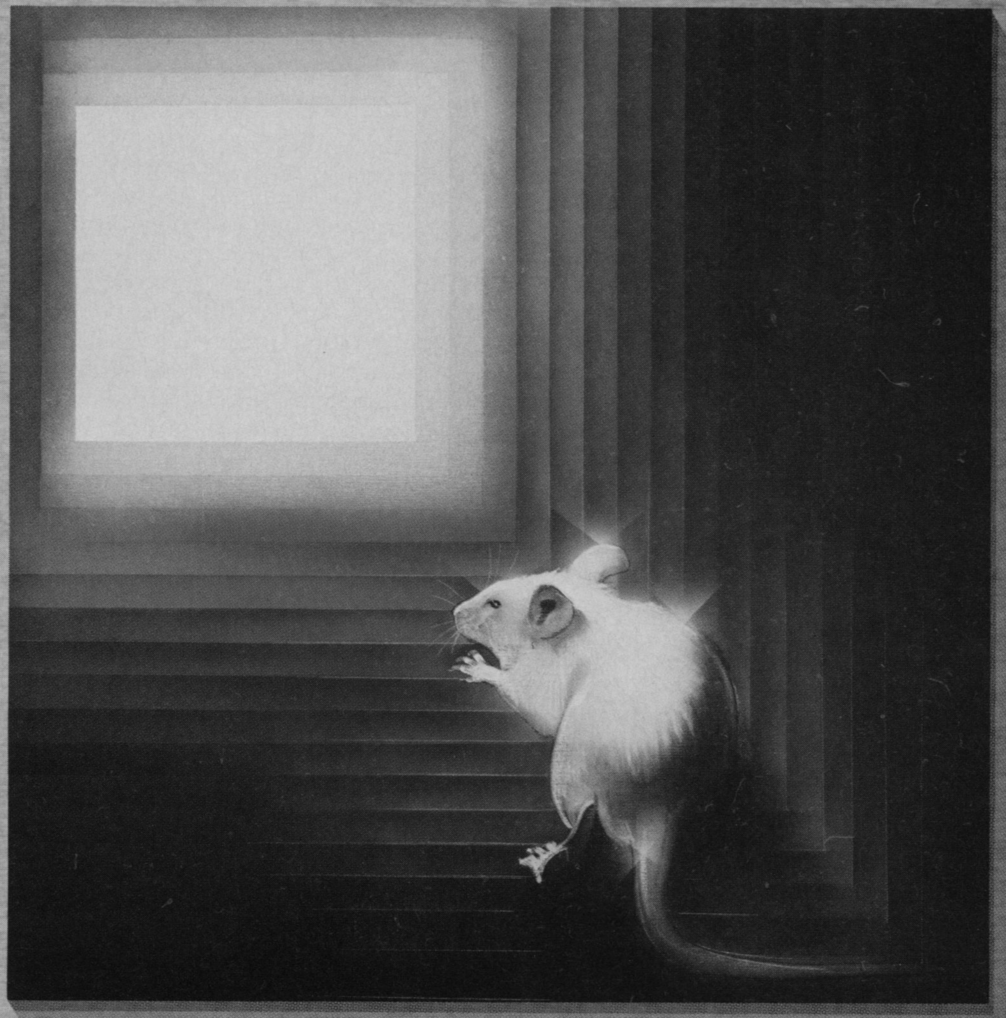
A knowledge of the thermal history of sedimentary basins is important in locating resources such as petroleum. The fine particles of clay minerals in a rock sample can contain a record of this history because hydrothermal processes can change the relative size and number of these particles. Eberl *et al.* (page 474) have read the history of one such process, Ostwald ripening, in the particle size distribution of a sample of the mineral illite. During Ostwald ripening, larger crystals grow at the expense of smaller particles, which dissolve in the interstitial fluid. This process minimizes the total surface area of the material. The size distribution can be compared with models of the dependence of the ripening process on particle radius. The separated particles can be analyzed by chemical, structural, and isotopic methods so that the timing of these recrystallization processes can be related to sample's geological history. Most clay minerals are on a "one-way trip" toward coarser crystals, so the largest particle also contains the most complete history of the ripening process.

Freeing phosphorus

PHOSPHORUS is often a limiting nutrient of plants, especially in soils where it is tightly bound by iron or aluminum oxide. One crop that does especially well in low-phosphorus soils is pigeon pea, a legume that is widely cultivated with cereals and other crops in semi-arid regions. Ae *et al.* (page 477) report that pigeon pea can solubilize iron-bound phosphorus by exuding piscidic acid and one of its derivatives from its roots. These acids probably bind Fe^{3+} by chelation release and phosphorus. Pigeon pea may be able to increase the pool of available phosphorus in marginal soil environments to the benefit of other crops, such as soybean and sorghum, that do not secrete these acids. Intercropping with pigeon pea offers an alternative to costly fertilizers in resource-poor areas.

■ PHILLIP SZUROMI

Stalking Cancer



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