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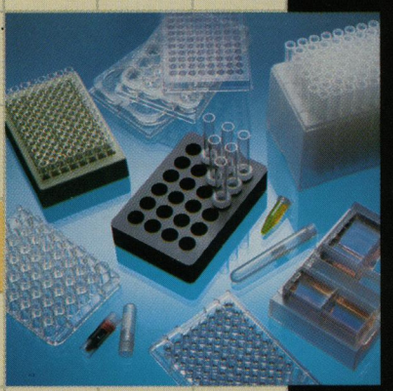

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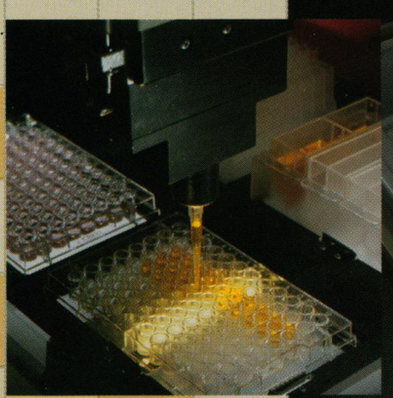

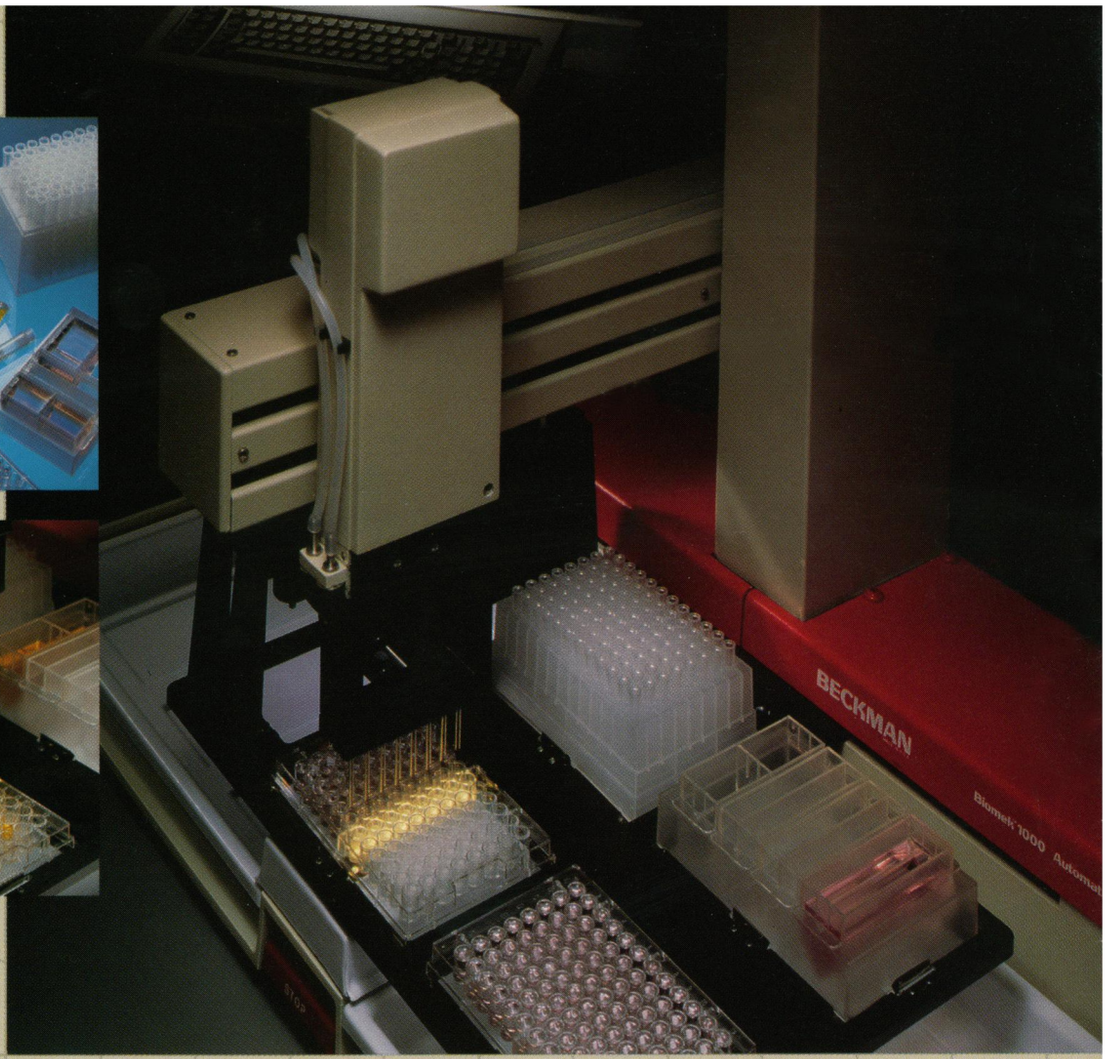

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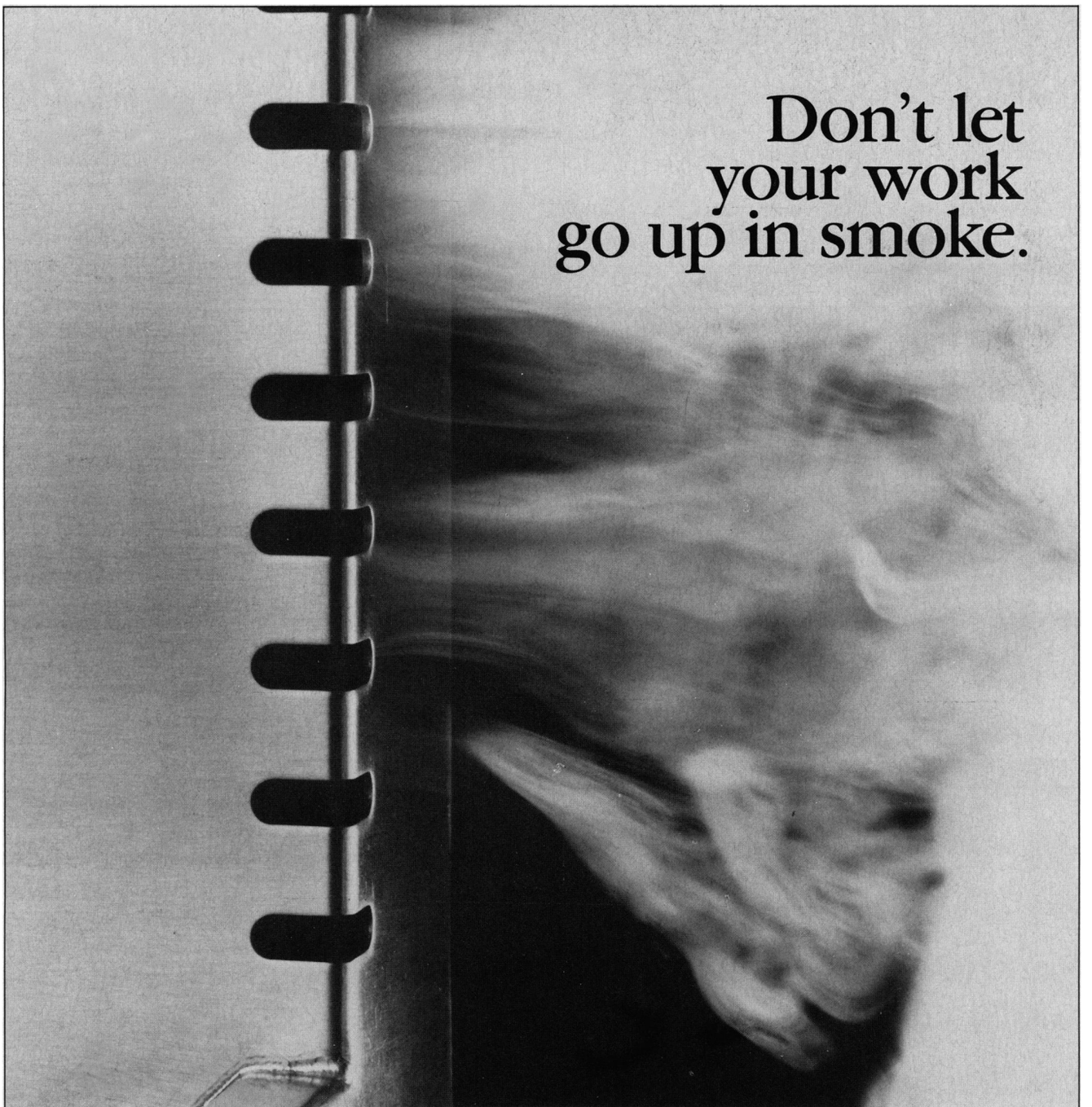

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COVER Mount St. Augustine volcano, Alaska, in pyroclastic flow eruption, 29 August 1986. View is toward the volcano (hidden in clouds) from Burr Point, 6 kilometers from the summit. A pyroclastic flow at the 350-meter level on the northern flank of the volcano is moving toward the camera at a speed of about 30 meters per second. The flow is a dry density current of dust, gas, and volcanic rock debris that probably originated by sudden vesiculation of molten andesite near the base of an emerging lava spine on the summit dome (about 1200-meter level). The ridge in the foreground is part of an 1883 debris avalanche that produced a tsunami in lower Cook Inlet. See page 1442. [Jürgen Kienle, Geophysical Institute, University of Alaska–Fairbanks, Fairbanks, AK 99775-0800]

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This Week in
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Time's arrow

Is there directionality to the evolution of life (page 1437)? Gould *et al.* address this issue through quantitative analyses of the shapes of clade diversity diagrams that illustrate the history of diversity in clades (segments of an evolutionary tree). Taxonomic groups originate with single species, expand, reach maximum diversity, and then decline. For extinct taxonomic groups, a center of gravity (*CG*) in the clade diagram can be calculated at which mean diversity was reached. *CG*s were calculated for more than 700 clades of extinct marine-dwelling invertebrates and more than 100 clades of extinct terrestrial mammals. Similar patterns of change in *CG*s were documented: the earliest clades of invertebrates (originating in Cambrian and Ordovician times) and mammals (originating in Paleocene times) had *CG*s of less than 0.5; thus peak diversity occurred early in the clade's evolution. Later-arising clades (Silurian and later invertebrates; Eocene and later mammals) showed greater symmetry ($CG = 0.5$) or slower attainment of maximum diversity. Thus another "arrow of time" has been defined suggesting that there are patterns in and order to evolution.

Tsunami prediction

VOLCANIC eruptions sometimes trigger tsunamis (tidal waves) that can cause tremendous destruction, particularly if the waves hit coastal communities at high tide (page 1442). Therefore, in 1986 when the Alaskan volcano Mount St. Augustine (cover) entered its sixth recorded eruptive cycle (since its discovery in 1778 by Captain Cook), one part of the emergency planning included development of models of hydrodynamic events that could be generated by the eruption. The most common cause of tsunamis of volcanic origin is displacement of seawater by an avalanche of debris falling into the sea and the outward rush of a great wave. In the simulations, Kienle *et al.* chose sites at which volcanic debris might enter the sea. The directions, heights, and times of arrival of great sea waves predicted by the models were in fair agreement with events of a previous eruption described by eye witnesses; in that explosive eruption 100 years earlier, Mount St. Augustine split in two, much of one side collapsed into the sea, and a destructive tsunami was triggered. Although parameters used in the simulations were specific for Mount St. Augustine, the same approach can be used to predict and prepare for tsunamis that might result from other coastal volcanic explosions. A tsunami did not accompany the recent eruptions.

Genome mapping

THE bacterium *Escherichia coli* has once again been used for pioneering studies in molecular biology; this time, the DNA of *E. coli* was used to illustrate strategies for physically mapping a complete genome (page 1448). Smith *et al.* used the restriction enzyme Not I to cut the *E. coli* genome into a relatively small number (22) of fairly large fragments; the fragments ranged in size from 15 to 1000 kilobases. These were separated from each other by pulsed field gel electrophoresis, a technique that readily resolves large pieces of linear DNA in the 50- to 1500-kilobase range. The fragments were isolated, identified, and aligned with the use of a number of recombinant DNA and mapping techniques as well as clues from other genetic and physical studies. The game plan described for constructing a physical map of the *E. coli* genome can be applied to the mapping of other genomes, including the human genome, whether or not genetic maps are available.

Pangea breakup

IT is thought that at one time all of the earth's continents were contiguous and formed a supercontinent called Pangea; new information about the timing and sequence of events that surrounded the separation of North America from Pangea is described by Traverse (page 1469). In the fragments of rock obtained during oil drilling operations, fossil pollens and spores were found; these had settled in sediments in a chain of rift basins that extended from Newfoundland to northern Mexico. The formation of the basins, known as the Newark basins, preceded by millions of years the actual breakup of Pangea. Sediments began collecting in these basins in the Karnian age of the Late Triassic period (more than 200 million years ago). The process of sedimentation ended first in the south; it ended in the north about 25 to 30 million years later—in the Jurassic period—with genesis of the Atlantic Ocean. Besides providing dates for these events, the fossils also provide information about climate conditions at the time of Pangea's breakup.

Sulfur cycling

SULFUR bacteria living in mats are important in diverse oceanic food webs, including those in shallow waters along coasts and in harbors and those at deep hydrothermal vents (page 1472). Grant and Bathmann describe the appearance of *Beggiatoa* mats from a sandflat in Nova Scotia; with a scanning electron microscope, bacteria, sediments, sand, flocculent materials, and an extracellular matrix of mucus were seen. The bacteria oxidize sulfides in the water, fixing sulfur and sulfates into the mats; gastropods and other organisms use these and other organic materials for their own metabolic processes. Cores through the mats into the sediments beneath were taken in spring and summer (when ocean waters ranged from calm to turbulent) and illustrated the apparently significant contribution to sulfur removal made by waves, tides, and currents. In laboratory flow experiments, resuspension and disruption of mats was confirmed and shown to be a powerful process for recycling sulfur to the water column. Physical transport may thus be as important as physiologic processes in sulfur cycling in the sea.

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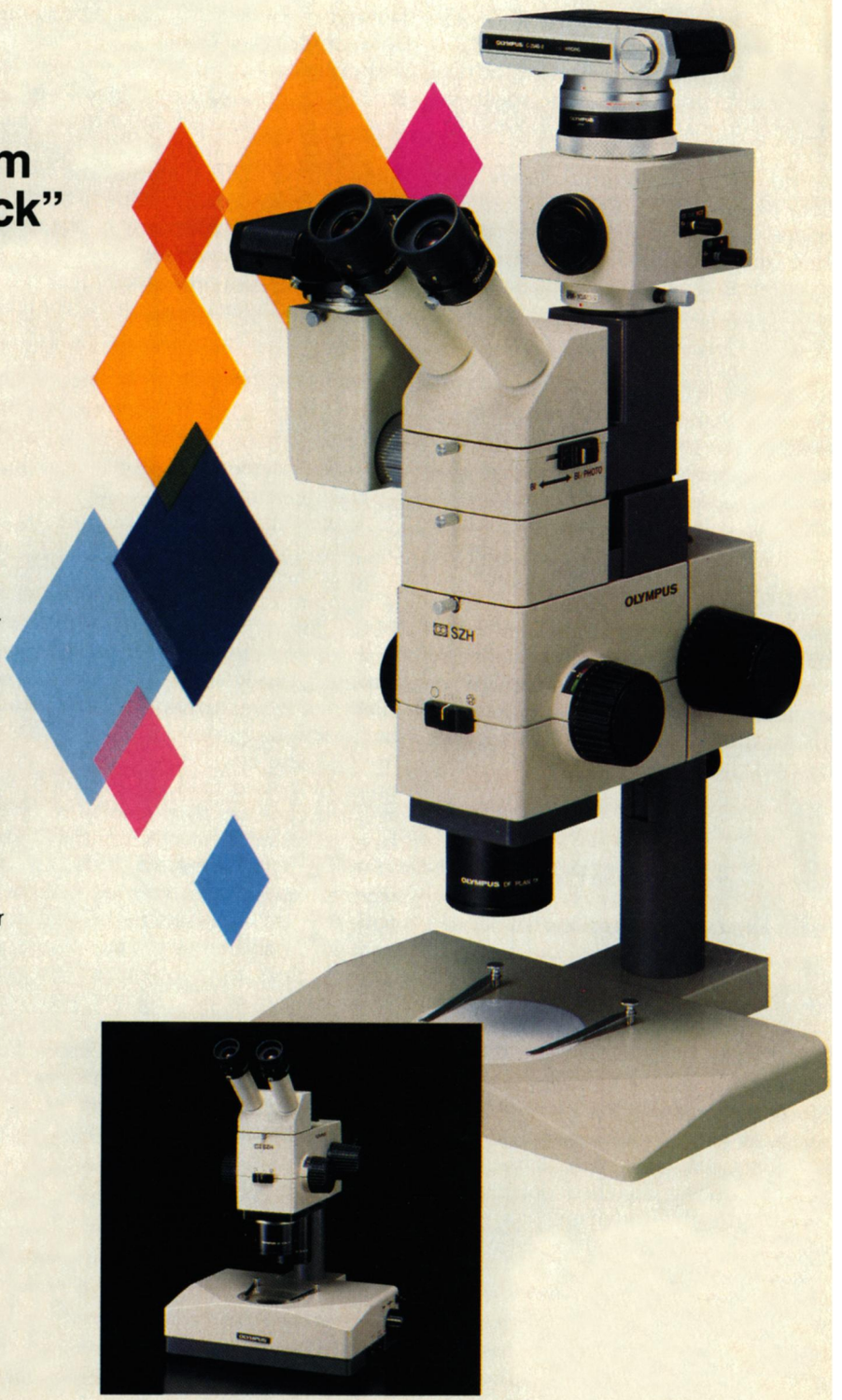

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Municipal Waste

The 6000-mile odyssey of a U.S. barge seeking in vain to dispose of its 3100-ton cargo of trash has drawn national and international attention to an approaching crisis in municipal waste management in this country. The United States generates an average of more than 400,000 tons of municipal waste a day. The per capita contribution is about twice that of citizens in other developed countries. Before the 1960s, most trash was burned in open dumps or in poorly functioning incinerators. The practice was curtailed when clean air legislation was enacted. Disposal then shifted to so-called sanitary landfills. At present, more than 90 percent of municipal wastes are buried. But time is running out on burial. Many dumps have reached the limits of capacity, and by 1990 half of them are expected to be closed. Around the country there is strong opposition to locating new landfills in any particular neighborhood. In addition, there is growing recognition of contamination of ground water by leachate from the dumps. My guess is that the situation in many of them will be found to be more serious than that at some of the Superfund sites. The Fresh Kills landfill on Staten Island discharges 4 million gallons of toxic leachate per day.

What makes effective waste disposal a particularly difficult problem is the complexity of the trash. The composition also differs from place to place. On average, the major components are paper and paper products, yard wastes, food wastes, and moisture. But in addition, the trash contains glass and ceramics, metals, plastics, and anything that is not wanted, including paint cans, spray cans, solvents, and potentially flammable or explosive materials. Obviously, segregation of components at households and separate collection of them would make both recycling and residual disposal easier. This is a practice often employed in other countries, but rarely here. If anything, this country has retrogressed with respect to segregation and recycling since the 1970s.

The present usual alternative to landfill disposal is to incinerate the waste, thus reducing the volume by about 90 percent. If noncombustibles and moist garbage are separated first, temperatures in the furnace can be sufficiently high to destroy all organic matter. The heat produced can be used to generate electricity. However, critics have raised questions about burning unprocessed trash. When excessive moisture is present, temperatures in the furnace will be limited, and dioxins and other hazardous chemicals may be created. In Europe,* incinerators are closely monitored to ensure complete combustion of organics, and scrubbers are employed to eliminate acid gases such as hydrogen chloride. In the United States, neither the federal government nor the states have established a full range of performance monitoring and standards. Incineration plants known to be functioning poorly have not been shut down. The politics of the situation make it far easier for the Environmental Protection Agency to be tough on industry than to deal with municipalities.

An alternative to complete dependence on incineration is biodegradation of waste. This is particularly applicable when the trash consists mainly of moist food residues and paper. When the treatment is conducted anaerobically, the principal products are carbon dioxide and methane, a good fuel.

Because landfills are reaching capacity and few new ones are being authorized, the cost of disposing of wastes is increasing. Six years ago, tipping charges (cost of dumping trash) were as low as $5 a ton in some places. Now the average is $25 and going up. Philadelphia has paid $90 a ton to have some of its wastes deposited in Ohio. As more and more landfills are closed, tipping charges will increase. There will be an additional financial incentive to develop improved practices for separating components of the waste, either at the household or following collection.

With the imminent closing of landfills, many cities are building or planning to build incinerators. Before new air pollution problems are created, lessons should be learned from other developed countries that have in place standards, monitoring, and trained engineers to operate the plants.—PHILIP H. ABELSON

*See A. Hershkowitz, *Technol. Rev.*, in press.

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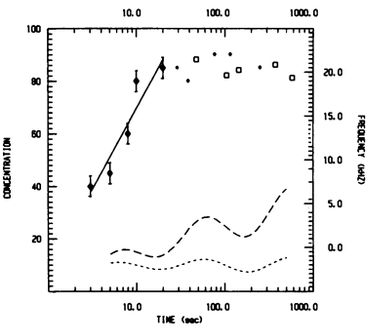

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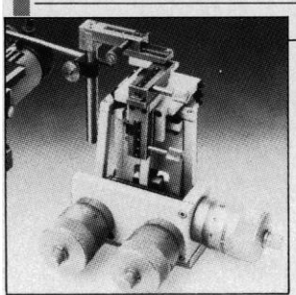

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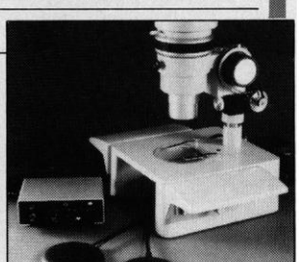

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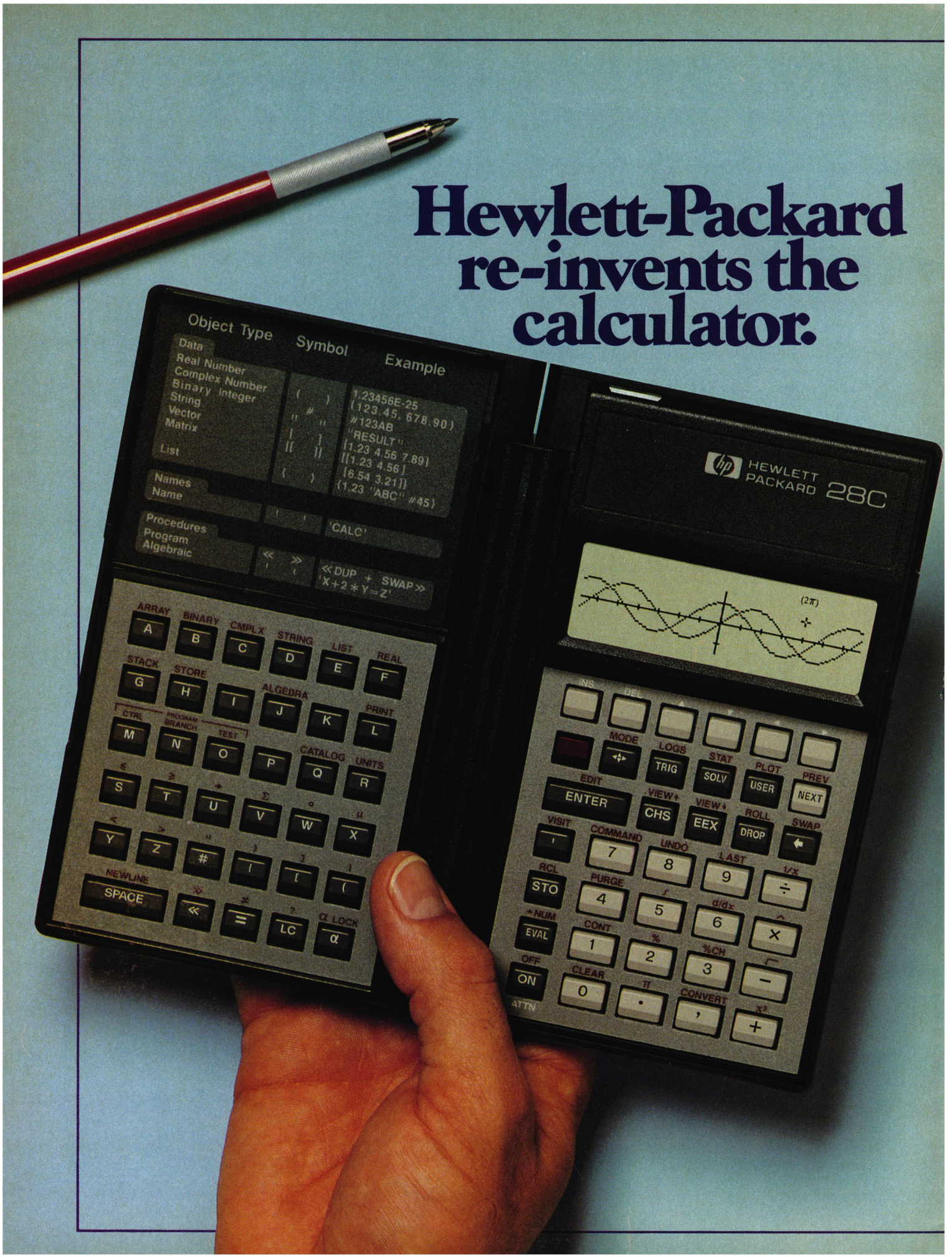
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"RESULT"
[1.23 4.56 7.89]
[[1.23 4.56]
[6.54 3.21]]
{1.23 "ABC" #45}
Names
Name
Procedures
Program
Algebraic
'CALC'
≪ DUP + SWAP ≫
'X+2*Y=Z'
HEWLETT PACKARD 28C
(2π)
ARRAY
BINARY
CMPLX
STRING
LIST
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STACK
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PRINT
CTRL
PROGRAM
BRANCH
TEST
CATALOG
UNITS
NEWLINE
SPACE
α LOCK
INS
DEL
MODE
LOGS
TRIG
STAT
SOLV
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USER
PREV
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EDIT
ENTER
VIEW↑
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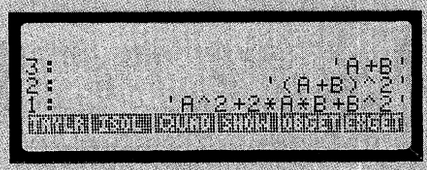

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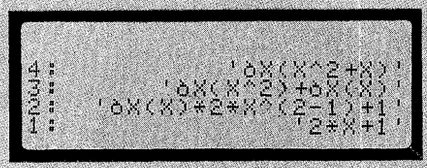

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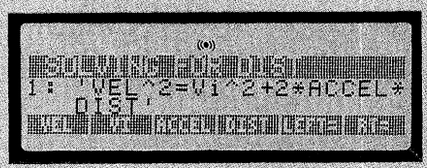

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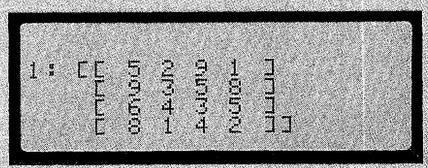

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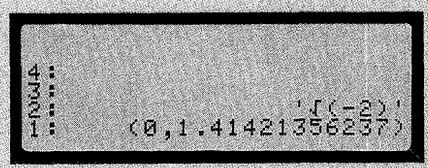

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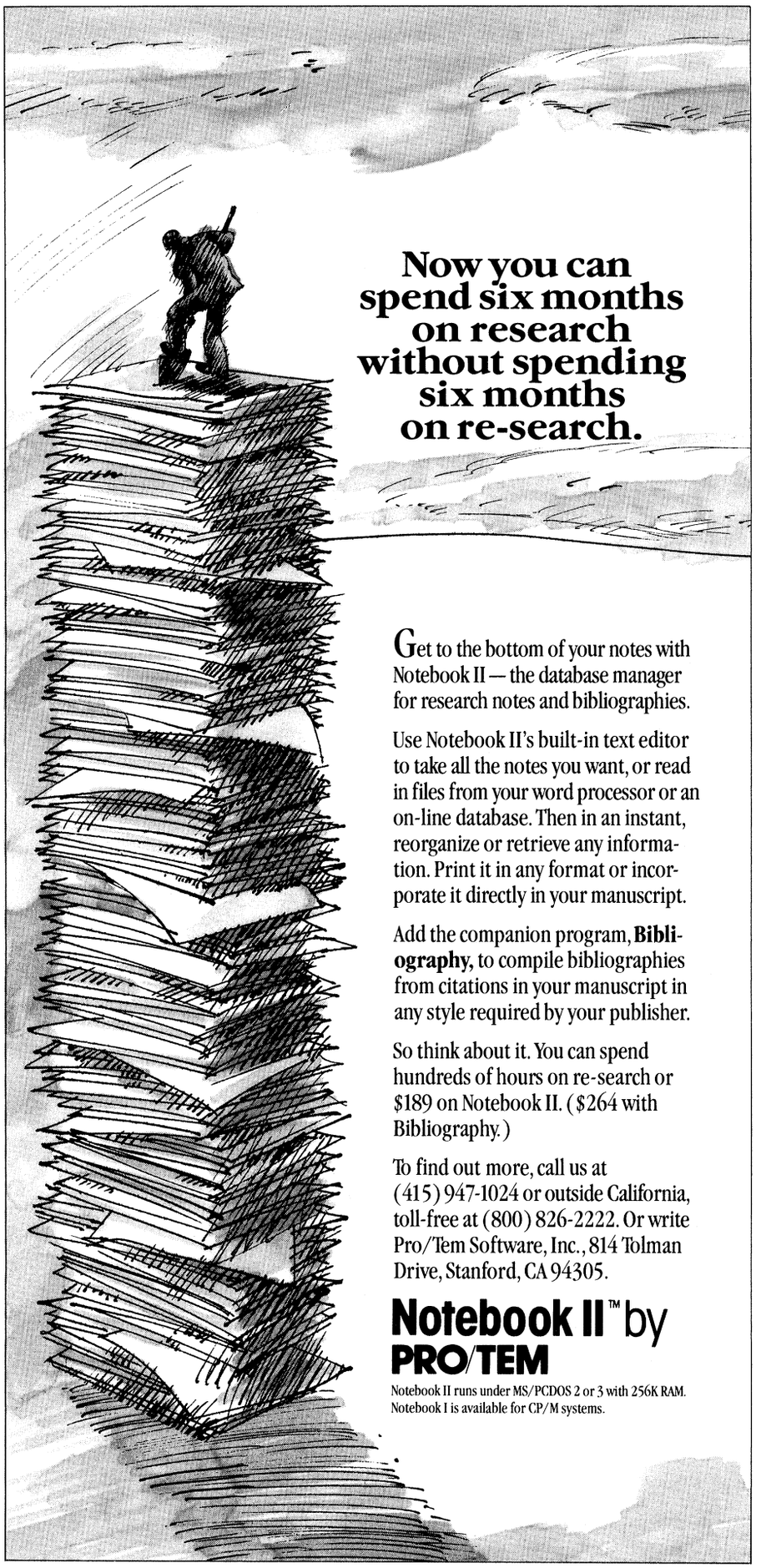

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