

# Barrier to Parallel Computing Overcome

A small team of scientists, engineers, and mathematicians in Computer Sciences and Mathematics Org. 1400 has found ways to solve complex scientific problems at unprecedented speedups. By developing innovative new methods and algorithms for parallel computing, they have obtained greater than thousandfold speedups on problems typical of, and important to, scientific computing.

These record-setting speedups have broken through a psychological barrier about the general-purpose usefulness of large numbers of parallel processors. (Speedups are a measure of the increased speed at which a problem can be solved on a multi-processor parallel computer in comparison with a single-processor computer.)

"We have achieved results that most computer scientists thought impossible a couple of years ago," says John Gustafson of Parallel Processing Div. 1413.

"These new parallel-processing methods have the potential to provide the extra computer throughput needed to make breakthroughs in computational science," adds Gil Weigand, 1413 supervisor.

The team's achievements required developing mathematical and computational methods for solving problems on a parallel-processing machine. These methods are tailored for handling very large scientific problems at high speeds using parallel computing (see "Readers' Guide to Parallel Processing" story).

The algorithms — recipes, in a sense — that the team developed have been programmed to run on Sandia's "hypercube" parallel supercomputer. It consists of 1024 small but powerful computer processors, linked together so that they can work simultaneously on different parts of a single problem. Linking more than a thousand processors in parallel is called "massive parallelism." Parallelism can make problem-solving much faster than addressing the parts in sequence, one at a time.

## 'Practical Barrier' to Speedups Broken

A group consisting of John, Bob Benner, Gary Montry (all 1413), and David Womble (1422) achieved speedups that were nearly in direct proportion to the number of processors that are linked together. This unprecedented achievement sharply differs from what currently accepted beliefs about parallel computing would predict.

In fact, before these results, the popular belief in industry and academic computing circles (based on a speedup theory called "Amdahl's Law") was that no matter how many processors might be linked in parallel, the problem-solving speeds could be increased by, at most, 50 to 100 times that of a single processor; the increase would be limited by the small portion of any computer program that cannot be run in parallel.

The speedup results have shown that this supposed "practical barrier" to dramatic improvements in speed simply does not exist for massive parallelism when the problem size is increased (scaled) in proportion to the number of processors. (In practice, this scale-up almost always occurs with the large, complex scientific problems that interest real-world scientists and engineers.)

"This way of looking at parallelism should have a big effect on parallel computing in the next few years," says Ed Barsis, director of Computer Sciences and Mathematics 1400. "We have shown that obtaining high performance on massively parallel computers is not an insurmountable task."

On three practical, full-scale, scientific application problems, the team achieved speedups of 1020, 1019, and 1011, respectively — almost the maximum of 1024.

"We believe these speedups are without precedent," Bob, John, and Gary state in a just-prepared description of their findings.

"The experiments and theory showing that speedup for large problems is not constrained by

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A BIT OF QUICK WORK with checks and plaques is not all this team is known for. Bob Benner (left), John Gustafson, and Gary Montry (all 1413) returned from the recent COMPCON (computer conference) in San Francisco with plenty of proof that the rest of the parallel processing world has recognized their success in achieving dramatic increases in the "speedups" of problems solved on a 1024-processor computer.



# LAB NEWS

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## An Important Issue

# Sandians Study Ancient Seawater

Trapped in salt beds that lie more than 2000 feet below ground at the site of the Waste Isolation Pilot Plant (WIPP) are the last traces of a 230-million-year-old sea — traces of seawater that the Geochemistry Division (6233) has been studying for several years as part of ongoing site characterization activities.

Some of the seawater is encapsulated in small cavities (formally called fluid inclusions) scattered throughout the salt beds. A few are large enough to be seen with the naked eye. Like tiny translucent pearls, they hang suspended in great chunks of transparent, recrystallized salt — salt that re-formed into larger crystals identical in composition to the original grains (see photo).

Traces of seawater can also be seen in "weeps" — damp places — on the freshly excavated walls in the repository and as seepage into holes drilled in the floor.

To the casual observer, the ancient seawater — whether trapped in inclusions or emerging in weeps — appears to be all of a kind, no different from any present-day seawater.

Not to Carol Stein and Jim Krumhansl (both 6233).

But they're not just casual observers. They recently collected more than a hundred samples of the brines (concentrated seawater) from different locations within the repository and analyzed the composition of each.

"By identifying the proportions of the elements common to seawater contained in each brine," says Carol, "we are learning how and when the brines were trapped in the salt and their probable subsequent history — something that sheds light on their



DROPLETS OF SEAWATER more than 200 million years old are trapped in the chunk of rock salt held by Carol Stein and Jim Krumhansl (both 6233). Their recent study of the trapped seawater may provide new answers to questions concerning the origin and history of brines at the WIPP site. An account of their study, "A Model for the Evolution of Brines in Salt from the Lower Salado Formation, Southeastern New Mexico," is scheduled for publication this month in *Geochimica Et Cosmochimica Acta*. Carol and Jim are also recipients of the Best Technical Paper Award given by the Waste Management 86 Symposium for their paper, "Geochemical Overview of the Waste Isolation Pilot Plant near Carlsbad, New Mexico." possible future interaction and migration within the repository.

That's an important issue.

Ancient salt beds appear to be ideal natural structures for the safe disposal of nuclear wastes. Nearly impermeable, their very existence implies the

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# Antojitos

**Who's This "Sandia"?** -- That was a common question among the computerists attending COMPCON 88 last week in San Francisco. It got answered, and decisively, when famed researcher Alan Karp announced that Sandia had met a challenge he'd figured wouldn't be met until the mid-90s and called the achievement "a fantastic piece of work."

It was answered again, before a packed house, when computer guru Gordon Bell mentioned Sandia's speedup breakthrough four times in his "Industry Update" keynote address -- which culminated with his presentation of first place in the first Gordon Bell Award competition to Sandia's parallel-processing team.

The team shattered accepted notions of "practical speedup" -- not bad for nobodies (until now) in the parallel processing arena. Even so, "it will take a while for the significance of what Sandia has done to sink in," says Ed Barsis (1400).

\* \* \*

**This One Didn't Take** -- ILC (Individualized Learning Center) Coordinator Cathi Brunacini (3522) is used to getting course materials returned from anonymous Sandians embarrassed at having borrowed them 5 or 10 years ago. But she was just a bit nonplussed when a secretary of a recent retiree returned a course that her former boss had stashed in his desk. It had been borrowed in December 1975, and she thought Cathi might like it back. (Turns out it's obsolete now, but thanks anyway.)

Oh, yes, the name of the course: "You Can Remember," a how-to-improve-your-memory course.

\* \* \*

**'Twas Only an Only** Fellow crochety curmudgeon Jim Mogford (400) suggests a couple of grammatical eyeball-grabbers he (and I) could well do without. One is "data" used as a singular -- "The data is unambiguous," for example.

Another is the misplaced "only." The guideline is simple -- put it next to the word it's restricting. Don't do what one newsletter -- written for professional communicators, for Heaven's sake -- did in creating a scenario: "You're employed by a public utility that only makes the front page when it's fighting for a rate increase." In this case, I submit that that "only" makes sense only when it's in front of "when."

Jim challenges those who say it doesn't matter to insert "only" throughout this sentence: She said that she loved me. Like this --

Only she said that she loved me.  
She only said that she loved me.  
She said only that she loved me.  
She said that only she loved me.  
She said that she only loved me.  
She said that she loved only me.  
She said that she loved me only.

I'll grant you, and I think Jim would too, that the last two versions communicate identical thoughts. But the preceding ones definitely do not.

●BH

\* \* \*

The attention span of a computer is only as long as its electrical cord.



WHEN POSTERS LIKE THIS ONE displayed by Lettie Carroll (3412) begin appearing in your building, you'll know "It's Cleanup Time" for your section. For help with special problems or questions, "it's Trashbusters to the rescue," says Lettie. "Just call the coordinator at the number listed on the poster, and help will be on the way."

## Don't Stash It, Trash It!

It's cleanup time! But then, it's *always* cleanup time -- in one section or another -- here at Sandia.

The annual lab-wide cleanup campaign, in full swing since January, has already made a clean sweep of two geographical sections of the Labs, including Bldgs. 814, 800, 802, 804, and 836. Each month for the rest of the year, another section of the Labs will be de-trashing, de-littering, and (it is hoped) delighting the members of management who will tour the section at the end of the month.

This month Section 3 (the entire northeast corner of the Labs, including the cafeteria) is scheduled for cleanup. John Holmes (6226) is the cleanup administrator for this section. (See box for other administrators and section schedule.) If you want to know which section you're in or need other general information about cleanup, call Don Gatto (3412), 4-2546.

Special "Trashbuster" posters are a new feature of the cleanup campaign. Created by Fay Ganzerla (3155), they'll begin appearing in each section as its month for cleanup rolls around.

"We borrowed SNLL's trashbuster theme," says Lettie Carroll (3412), "but Fay created a distinctive new logo for us. Everyone will be able to tell at a glance whom to call for help with special problems during cleanup."

"We want to remind everyone," continues Lettie, "that disposing of any kind of waste that might be considered hazardous is *always* a special problem and requires approval by the experts in Environment, Safety, and Health Dept. 3310. Call them at 4-4966."

A representative from Environmental Protection and Hazardous Waste Management Div. 3314 will accompany the management walk-through, as will representatives from the Capital Planning and Control Div. 144 and Custodial Services Div. 3426.

Section	Administrator
1 (Jan)	Bob Eldredge, 3412
2 (Feb)	Tom Hobart, 7481
3 (Mar)	John Holmes, 6226
4 (Apr)	Rod Geer, 1100
5 (May)	Pat Childers, 9000
6 (Jun)	Lou Roper, 7810
7 (Jul)	Jo DeHerrera, 2100
8 (Aug)	Debbie Eaton, 5200
9 (Sept)	Waylon Ferguson, 2500
10 (Oct)	Ed Kozlowski, 1200
11 (Nov)	Jim Bryson, 6452
12 (Dec)	Tom Workman, 7530

## LAB NEWS

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## Sympathy

To Clif Selvage (8234) on the death of his stepfather in San Luis Obispo, Feb. 10.

To Gene Simpson (8132) on the death of his mother in Seaside, Oreg., Feb. 11.

To Val Pestanas (8441) on the death of her sister in Sacramento, Feb. 14.

To Pat O'Brion (8532) on the death of his mother in Livermore, Feb. 25.

## Congratulations

To Kellee and Robert Dankiewicz (both 8271), a son, Matthew Thomas, Feb. 21.

## Mussel Power



In order to attach itself to a surface, the mussel secretes a sticky glue that is as powerful as epoxy; it offers the additional advantage of working even under water. After 10 years of effort, J. Herbert Waite of the University of Connecticut has identified [and] synthesized the material. Because the adhesive binds in a wet, saline environment, it is expected to be effective for tooth repair and perhaps for mending broken bones or injured tendons. Moreover, it has the remarkable property of not accepting another adhesive once it sets. Hence the U.S. Navy, in what a mussel might regard as the ultimate irony, hopes to employ the adhesive as a coating for ship hulls to prevent fouling by marine organisms.

Scientific American

Two combustion physicists — Roger Farrow (8354) and Larry Rahn (DMTS, 8354) — are the co-recipients of the 1988 O. W. Adams Award at Sandia Livermore.

The honor goes to those who have made the most outstanding contributions in Combustion Research Facility (CRF) programs during the past year. It was named for the late Bill Adams, who was with DOE's Office of Basic Energy Sciences in Washington, and is considered the "founding father of the CRF."

Roger, who joined Sandia in 1979, was selected for his important contributions to the science of CARS (Coherent Anti-Stokes Raman Spectroscopy) measurements in reacting gases, especially for his leadership in making measurements that define the CARS forefront.

In making the presentation, Peter Mattern, Director of Combustion and Applied Research 8300, noted that Roger is "nationally and internationally recognized in his field. He exemplifies what the CRF is all about — performing the highest quality research, collaborating with internationally recognized combustion researchers, and, as a consequence, attracting widespread support for Sandia's combustion program."

Larry, who came to Sandia in 1976, was recognized for his continuing outstanding contributions to the fundamental understanding of laser interactions with gases. His work provides the basis for much of the widely recognized work on non-linear spectroscopy in flames.

"Larry has done pioneering diagnostics work in developing new methods for combustion applications," said Peter. "His early combustion-related assignments were difficult and high-risk, but they were successful from both the scientific and program-



CO-RECIPIENTS OF THE ADAMS AWARD, Larry Rahn (DMTS, left) and Roger Farrow (both 8354), hold the plaque that was presented to them by Peter Mattern, 8300 Director.

matic points of view."

According to Peter, the Adams Award has particular significance "because of the peer recognition derived from the selection process. We recognize the recipients for blending excellence in science with those other accomplishments and attributes that, taken together, help make the CRF the paradigm for

government-supported 'user' facilities."

The award has been given twice before — to Jim Miller (8353) in 1985, and to Pete Witze (DMTS, 8362) in 1986. Roger and Larry each received a personalized plaque during a directorate meeting, and their names are engraved on the larger version that hangs in the lobby of the CRF.



## SANDIA LIVERMORE NEWS

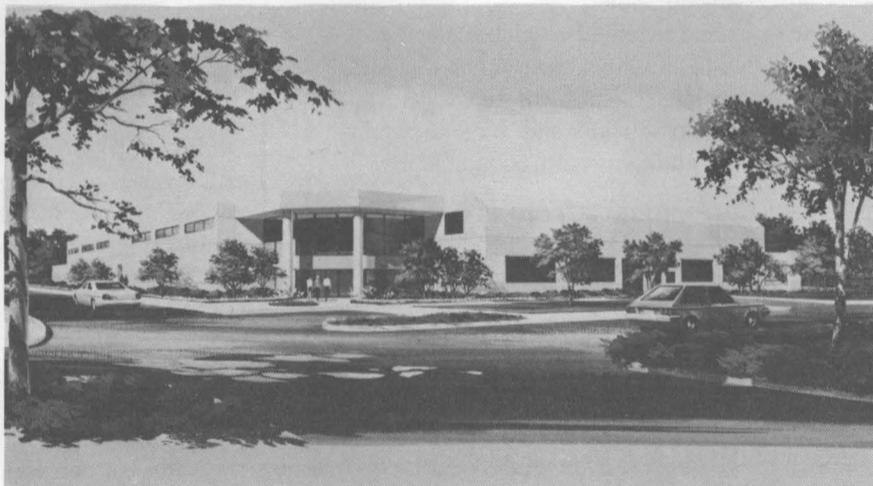
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SANDIA NATIONAL LABORATORIES

MARCH 11, 1988

## Defense Engineering Lab Slated for 1991

ARTIST'S RENDERING of Sandia Livermore's planned Defense Engineering Laboratory.



Construction of a new defense engineering laboratory for SNLL has been approved by Congress, and \$1.8 million has been appropriated for the initial architectural and engineering design phase.

Planned for completion in late 1991, the \$45.6-million, 85,000-square-foot facility will be located on the southwest side of the Sandia site.

Rick Wayne, Director of Component and Systems Research 8400, describes this project as the "first heavy-engineering laboratory ever built on this site." According to Rick, SNLL's current buildings cannot house all the engineering functions together and simply do not have the laboratory capabilities required for the sophisticated experiments Sandia has been asked to conduct.

"The original concept for the facility came about when we realized that some of the special environments needed for our directed-energy-weapon work were not available anywhere on site," Rick adds.

One of the unique features of the facility will be a Vibration Isolation Room. "None of our present buildings can provide a vibration-free environment," Rick explains. Many of the directed-energy concepts require precision tracking and pointing.

Devices based on these concepts have to be aimed and the target has to be tracked before firing; the necessity for accuracy will be much greater in

future SDI applications. To imitate the vibration-free environment in space, the construction will have to meet special requirements.

### Not Designed Only for NDEW Program

"We wanted to be sure we were building a facility that could be used for a wide variety of heavy-engineering work, regardless of the direction the

NDEW weapon program takes eventually," Rick notes. "For example, the air-filtration system will permit certain 'clean' rooms to operate at a Class 1000 level [which allows no more than 1000 particles larger than one micron per cubic metre], and will provide precise humidity and temperature controls."

The new structure will be occupied by portions of Materials Department 8310, Physical Science Department 8340, and Exploratory Systems Department 8430. About half the building will be used for physics and materials research. This facility (and the upcoming addition to the Combustion Research Facility) will have a system to collect and sample liquid effluents before they are discharged into the city sewer. The same type of effluent monitoring has been included in the nearly completed Weapons Engineering Lab (Bldg. 910) as a part of Sandia's enhanced program to protect the environment.

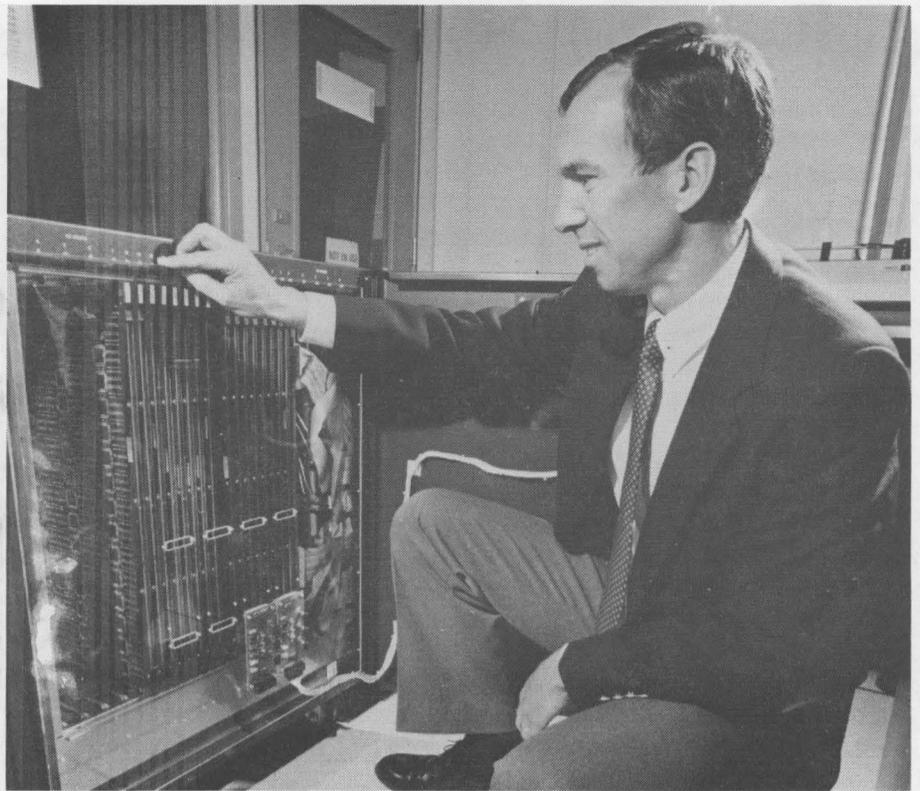
"The principal purpose of the new facility is to accommodate the kinds of technologies that are developing in SDI's directed-energy program," Rick concludes. "But no matter what direction SDI takes, we believe that much of what we are discovering and doing will be used in future weapon programs."



SANDIA LIVERMORE converted to its own telephone system on March 4 after AT&T completed installation of the necessary switching equipment in the basement of Bldg. 910. Handling the installation oversight and service conversion for Sandia were (from left) Adana Dean (8234), Clif Selvage (8234), and Gabe Gutierrez (8273). They are at the management control terminal for the AT&T 5 ESS digital telephone PBX.



ED BARSIS (left), Director of Computer Sciences and Mathematics 1400, still uses a lead pencil — at least for computational tasks not suitable for the massively parallel processing skills evidenced by the research team. “The team has put Sandia in the forefront of parallel computing research,” says Ed. Gil Weigand (right), supervisor of Parallel Processing Div. 1413, headed the research team’s successful effort



to show that Amdahl’s Law is not a major barrier to solving computational problems if they’re sized in proportion to the number of processors used. Here, Gil shows as much as can be readily seen of the 1024-processor hypercube computer on which his team achieved the recent breakthrough in massively parallel processing.

**(Continued from Page One)**

## Parallel Processing

“Amdahl’s Law is a very significant result,” says Venky Narayanamurti, Vice-President of Research 1000.

### New Ways to Solve Very Large Problems

The ability to take advantage of massive parallelism, coupled with the development of new massively parallel computers, could help open the way to solving wide-ranging problems that no computers now in existence can tackle.

The achievements are the first to emerge out of the research program in parallel computing that Sandia established in late 1986. The program goal is to develop supercomputing methods of the future and gain an understanding of the next generation of parallel processors.

“Sandia has made a long-term commitment to computational science,” says Pat Eicker, manager of Computer Sciences Dept. 1410. “Our intention is to push the frontiers of the field hard in order to open up new possibilities in solving very large scientific problems, the complex calculations that are Sandia’s bread-and-butter.”

Massively parallel computing — the focus of Sandia’s research effort — involves developing methods and algorithms for simultaneous operation of not

just a few but of a thousand or more processors — each as powerful as a stand-alone computer — all programmed to work together simultaneously on different parts of the same problem. “It’s in this area that our work has moved Sandia to the forefront,” says Ed.

“We decided to skip the hundred-processor level and go directly to working with a thousand and more processors,” Ed continues. “We anticipated that we’d be able to learn more about the challenges of parallel processing at that level. We’re succeeding at that. And we’re also gaining the understanding necessary to prepare us for future generations of parallel-processing computers.”

These newfound capabilities will be most useful, Gary notes, “not in solving present problems faster but in solving very large scientific problems that cannot now be handled practically and, for some applications, in solving problems more economically.”

### Optimum Performance from Hypercube

To allow the hypercube to achieve optimum performance, the problem size was allowed to increase with the number of processors. In other words, if a problem is small enough to fit the memory of a single processor, then spreading the same problem across 1024 processors means that the problem uses only 0.1 percent of the memory that’s available — that’s spreading data so thin that it’s a very inefficient appli-

*(Continued on Page Five)*

## Records Set in Solving Complex Problems

The dramatic speedups resulting from the work done in Computer Sciences Dept. 1410 have been achieved on scientific problems in mechanics, fluid flow, and wave propagation. All are problems large enough to challenge the 1024 processors used in the calculations. Just as important, all are problems relevant to Sandia’s R&D programs.

The 1020-times speedup was achieved on a nonlinear wave simulation — a calculation, by a method known as explicit finite differences, of the progress of waves traveling through various media containing objects that interact with the waves. The achieved speedup means that the new algorithms enabled the 1024-processor hypercube computer to execute the problem 1020 times as fast as a single processor would — if the single processor had access to the same

amount of memory as the entire hypercube has, 0.5 gigabyte, or about half a billion characters.

The 1019-times speedup was achieved on a structural mechanics problem — a calculation, by so-called finite element techniques, of the deflection of a solid beam under loading. Sandia regularly uses similar techniques to evaluate designs of weapon systems, the packaging of electronics, nuclear waste fuel canisters, and vertical axis wind turbines.

The 1011-times speedup was achieved on a fluid dynamics problem involving unstable fluid flow (the classical Kelvin-Helmholtz instability). Similar computer simulations of fluids are used at Sandia in combustion and explosives modeling and reactor safety modeling, to name but a few applications.

### Sandia First Winner

## Parallel Processing Speedups Earn Two Awards

Sandia’s recent achievements in parallel processing earned its computer sciences team two major awards last week.

The most prestigious is the Gordon Bell Award, which grants \$1000 to “the person or team that demonstrates the greatest contribution to parallel computing.”

The award, named for computer pioneer Gordon Bell (now president of Ardent Computer Co.), recognizes both speedup and throughput on full-scale problems in any field, including engineering, economics, and weather forecasting. Sandia won over 14 other entries from the US and Europe. Other winners were the National Center for Atmospheric Research, which took second place; a CalTech/Yale/AT&T Bell Labs collaboration, which took third; and the University of Pennsylvania, which took fourth.

The Gordon Bell Award is new this year, so Sandia is the first winner.

Award winners are chosen through a peer-review process. *IEEE Software* journal administers the competition, but judges come from industry and academia.

The second award is a challenge award. In 1985, Alan Karp of the IBM Scientific Research Center in Palo Alto, Calif., offered \$100 to “the first person to demonstrate a speedup of at least 200 on a general purpose, MIMD computer used for scientific computing.” He established several criteria any winner would have to fulfill to meet the challenge, which was to be in effect through 1995.

“These awards from the computer science community acknowledge the progress we’ve made and our leadership in parallel computing research,” says Ed Barsis (1400).

“We’ve definitely established a clear presence in computing research in a relatively short time,” adds Venky Narayanamurti, Vice-President of Research 1000.

The Sandia team received both the Gordon Bell and the Karp Challenge awards at the COMPCON (*computer conference*) in San Francisco on March 2.

## Readers' Guide to Parallel Processing

You want a large complex of condominiums built, and you want one (very talented) builder to do everything alone. He or she would have to do it in series, that is, sequentially, one step at a time. Even if the builder worked supernaturally fast, never ate, and never rested, it would still take quite a while to finish your condos.

If, however, you could divide the project into a set of tasks, then several members of a large construction crew could work in parallel — bricklayers laying bricks while plumbers install pipes while electricians string wires.

Basically, the latter choice is a kind of parallel processing. The analogy (adapted from *Scientific American*) is not without flaws — you couldn't have your roofers roofing before your walls were erected, for example.

Parallel processing approaches a highly complex task the same way. Each member of the "crew" of independently programmable processors is given a unique set of instructions; in computerese, that's called "multiple-instruction-stream/multiple-data-stream," or MIMD. The operators split a traditional computation problem into separate pieces, distribute the tasks and the data needed for the tasks among the processors, and let the processors run.

In the construction task above, the workers have to communicate. They have to stay in close touch with their neighboring workers to ensure straight walls, proper windows, necessary plumbing, and so forth.

### 'Nearest Neighbor' Communication

In this case, "nearest neighbor" communication would be logical. But if the task required a bricklayer on one wall to be in close touch with a bricklayer on the opposite wall, and the only way to communicate was to send messages via adjacent members of the crew, not many bricks would get laid — unless the bricklayers could lay bricks and relay messages simultaneously.

In parallel processing, a means for communications between processors and between processors and memory can be provided in several ways. One is to connect all the processors to a common memory system; that's called, logically enough, shared memory. With large num-

bers of processors, however, that can lead either to bottlenecks — slowdowns — or to large numbers of connections (hitching 1000 processors to 1000 separate memory banks would require a million connections).

The massively parallel processing system the Sandia team uses has 0.5 megabyte-worth of memory in each processor — a total of 0.5 gigabyte. These processor-memory pairs, called "nodes," function as independently as the algorithm developers can manage.

But in most computing problems, nodes need information from other nodes. In the method used by the Sandia team, no node calls for information that another node must return. Rather, a node with information to send simply sends it.

If the two nodes are not immediately adjacent, other nodes in the path can pass the messages. But message-passing does not necessarily stop their computational labors: that is, message-passing and computation overlap, a trick used to boost performance.

### Hypercube for Node-to-Node Messages

Several node "topologies" are relatively simple — rings, meshes, trees, for example. But for complex problems being worked in a massively parallel system, a more elaborate topology known as the hypercube alleviates the communication problem.

The term "hypercube" refers to an innovative type of computer architecture, first used just a few years ago. In a hypercube the nodes are connected as if they were at the corners of a multidimensional cube. For example, eight nodes would be connected in a three-dimensional cube topology. Sixteen nodes would be connected in a four-dimensional cube, one inside another. Generally, an  $x$ -dimension cube can connect  $2^x$  nodes.

The advantage of the hypercube topology is that each node can communicate with any other by a relatively short route. The longest path is proportional to the log of the number of processors — from which it follows, for example, that going from a thousand processors to a million would only double the maximum communication time.

acters) per second it can move. Each of its 1024 processors has about the same capability as a mini-computer and can operate independently.

Although Sandia's results were obtained on a hypercube, "our program in parallel computing is 'architecture-blind,'" says Gil. "That is, it's not dependent on the availability of a hypercube supercomputer. The real achievements came in exploiting parallelism with new mathematical methods and innovative algorithms for carrying out the calculation."

•Ken Frazier (3161)

### (Continued from Page Four)

cation for a massively parallel processor.

So, rather than fix the size of the problem, the team scaled the three problems up to "real Sandia world" size. That is, problem size was increased to match the number of processors. This is when the dramatic, thousandfold-plus speedups were achieved (see "Records Set in Solving Complex Problems" story).

"Two years ago the scientific community thought a 200-times speedup on practical problems like these was impossible," says John.

"We've gotten more than 1000," adds Bob. "In fact, we've come almost all the way to the theoretical limit for a 1024-processor machine."

The team's work was done on what is currently the world's largest — by a factor of four — operating MIMD (multiple-instruction, multiple-data) computer. It's an NCUBE/ten, a state-of-the-art, massively parallel hypercube supercomputer made for Sandia by the NCUBE Corporation, Beaverton, Ore.

But success was not simply a matter of buying a computer. The team spent the last year developing mathematical methods and algorithms, and learning the complexities of programming 256 parallel processors and then 512 parallel processors. All 1024 of the hypercube's processors were finally linked on Nov. 20, 1987.

Although physically compact (less than three feet on a side), it also holds the current world record in terms of numbers of sophisticated processors operating in parallel and in the 7.7 billion bytes (char-

## Fun & Games

**Bicycling** — A lab-vs-lab bicycle race, Sandia against Los Alamos, is planned for sometime in May. The event will be an 18-mile individual time trial followed by a 30-mile road race. Points awarded for individual placings will be added for the team score. Competition is open to Sandians and contractors, regardless of ability. Volunteers are also needed to help at the race. If interested, contact Neil Davie (7541) on 4-6431.

\* \* \*

**Bowling** — SANDOE Bowling Assn. Bowlers-of-the-Month for January are: Scratch — Leo Bressan (ret.), 665; and Shirley Spalding, 582; Handicap — Silviano Candelaria, Jr., (7212), 603 and 687; and Karen Varga, 568 and 667.

Winners of the 4-Game Mixer tournament at Iceland Bowl on Feb. 20-21 were Tom Lutz (6514) and Enid Reasner (guest), with a 1499 combined handicap series. Second went to Ken and Cherly Wiltsie (guests), with a 1468 combined handicap series. The next tournament will be a 4-Game No Tap at Holiday Bowl on March 19-20.

\* \* \*

**Tennis** — The Sandia Tennis Association starts serving in mid-April. This year's planned activities include tournaments, leagues, ladders, and lessons. If you haven't received a registration form or would like more information, call Mark Tucker (5246) on 4-2346 or Charlene Schaldach (2645) on 4-6734.

\* \* \*

**Run & Walk** — It's no April Fool joke. The Fun Bunch Track Club plans to run and walk from Santa Fe to Chimayo on April 1. For more information about starting time, place, and rationale, contact Chuck Atencio (2832) on 4-6886.

\* \* \*

**Archery** — It's time to restring bows and renew membership in (or join) the Manzano Archery Club. Deadline is March 31. You don't have to be a member to shoot on this range. Contact president Dewey Reed on 4-4558 or 265-2687, or Kerry Lamppa on 4-2273 or 299-1119.

## Welcome

### Albuquerque

Carolyn Beeler (3322)  
Jonathan Sherer (2631)

### Colorado

Will Keener (3161)

### Florida

Celestino Corral (2533)

### Michigan

Cathleen Hutchison (3523)

### Ohio

Mathew Donnelly (7484)

## Computing Capabilities Meet Current Needs

The "far future belongs to" massively parallel processing systems, states Tony Durham, co-author of *Parallel Processing: The Challenge of New Computer Architecture*.

In the immediate future, however, Sandia's scientific computational systems are quite capable of meeting the Labs' needs. In December 1986, the Central Computing Facility in 2600 acquired the newest and most powerful Cray supercomputer, the X-MP/416. As its numerical descriptor suggests, it has four processors and 16 megawords of memory (or, with each word corresponding to 8 bytes, 128 million bytes). And its solid state disk has been upgraded to allow access to 256 more megawords.

"The new X-MP doubled Sandia's compu-

tational power," says Larry Buxton (2635). "It's the most capable off-the-shelf conventional supercomputer existing today." It is, in fact, five times more powerful than the other Cray in the 2600 stable, a Cray-1S/1000.

In addition to the X-MP/416, the Cray-1S, and a CDC Cyber 180/855 at SNLA, SNLL has an X-MP/24 and two Cray-1S/2000s.

And, of course, the computers in the two Central Computing Facilities are merely the largest conventional ones in Sandia's stable. Distributed throughout Sandia are 550 Digital computers (VAXes and PDPs), 800 Hewlett-Packard machines, and a host of smaller workstations used for such tasks as computer-aided engineering.

## Brines

absence of circulating ground water — the salt would have dissolved had water been percolating through it.

But because of the long standing concern that brines trapped in the salt beds might migrate into waste storage areas and corrode waste canisters — leading eventually to leakage of nuclear wastes and their migration out of the repository — the brines have been the subject of many kinds of studies since the inception of the WIPP project in 1975.

“The results of our study,” says Carol, “will provide another small piece in the overall puzzle of brine migration.” (Several other Sandians are currently conducting different kinds of investigations of the rates and volumes of brine movement as observed in the weeps and boreholes.)

Some questions are of special concern: How are the brines related? Have they mixed or intermingled? What is the source of the weep brines? Are brines escaping from the inclusions to form the brines seen in the weeps? Is very slow, large-scale movement of the brines occurring within the repository site?

“Our analyses of the compositions of the different brines are a good start toward answering some of those questions,” says Carol.

Stressing the preliminary nature of their work, Jim notes that further study is necessary before the brines in the repository are fully characterized.

### Baffling Diversity

But they’ve learned a lot already — not the least of which concerns the baffling diversity of the composition of the brines.

Their analyses showed that the compositions of all the brines varied considerably.

As a starting point for discovering the causes of these variations, Carol and Jim compared the compositions of the brines to the composition of present-day seawater.

Certain inherent characteristics of seawater make such a comparison useful.

The constituents of seawater include dissolved salts such as sodium, chlorine, potassium, magnesium, and others. Although the total amount of these salts may vary from place to place and from time to time, the relative proportions (the ratio of sodium to chlorine or of magnesium to potassium, for example) are remarkably constant in all seawater everywhere and have remained so, some geologists believe, for millions of years.

But as seawater evaporates and becomes extremely concentrated, its elements begin to crystallize to form minerals that precipitate (settle to the bottom) in a definite, predictable sequence. The composition of the evaporating seawater — the proportion of one element to another — changes accordingly.

When the original volume of water has been reduced by evaporation to about 30 percent, anhydrite begins to precipitate. At extreme concentrations, when the water reaches about 10 percent of its original volume, sodium and chlorine begin to crystallize to form halite (salt), which precipitates from the water. At about 5 percent of original volume, potassium, magnesium, and sulfate precipitate as a complex mixture of salts.

When seawater evaporated in the laboratory reaches these late stages of evaporation, it exhibits progressively changing ratios of sodium to chlorine and potassium to magnesium that are typical of late-stage evaporation.

Because the brines at the WIPP site are trapped in salt deposited during these late stages of evaporation, one might expect that the ratios of sodium to chlorine and magnesium to potassium in these brines would resemble the ratios observed in the last stages of laboratory-evaporated seawater.

They don’t.

Carol and Jim found that the brines they extracted from inclusions form two compositionally distinct

groups, and brines found in weeps or as seepage in boreholes exhibit another quite different range of compositions.

One group of the inclusion brines is enriched in magnesium relative to potassium but depleted in sodium and chlorine, compared with ratios of these elements seen in present-day seawater during late-stage evaporation.

A second group is depleted in magnesium relative to potassium, and has higher sodium and chlorine concentrations.

Their samples of weep and borehole brines, on the other hand, show even higher concentrations of potassium in relation to magnesium, compared with inclusion brines containing similar ratios of sodium and chlorine.

“Despite their diverse compositions,” says Carol, “all the brines, our analyses suggest, are the concentrated remains of the ancient sea that once covered the area of the Delaware Basin.”

“In all probability,” she continues, “their compositions once resembled the composition of present-day seawater during the final stages of evaporation.”

But something happened to alter the compositions of the brines.

### Sediment Accumulates

What happened, according to Carol and Jim, began hundreds of millions of years ago during the final stages of the evaporation of the ancient sea in the Delaware Basin. Through geologic conditions operating over a long period of time, great amounts of almost pure sodium chloride (salt) had precipitated from the evaporating seawater and accumulated on the basin floor (see “Delaware Basin: A Sea-Change” story).

Sedimentation rates for such deposits are very slow — extending to millions of years — during which many layers of salt and other minerals build up. Older sediments are progressively buried by younger sediments.

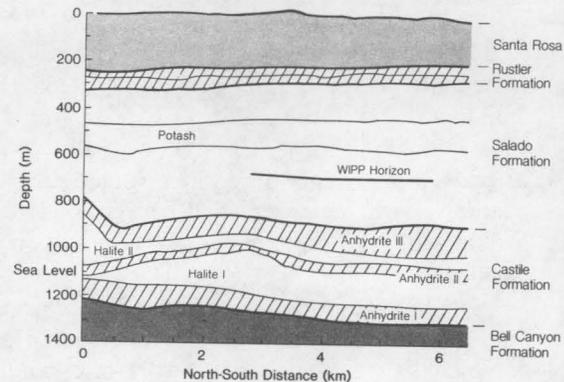
Burial of each layer is accompanied by physical changes caused by the weight of overlying sediment and by chemical changes due to reactions between elements in the highly concentrated seawater and minerals in the sediment.

These reactions involve the formation of new minerals and mineral replacement, a process that occurs when concentrated brine encounters minerals unstable in its presence. The brine dissolves the original mineral and at the same time deposits from solution an equal volume of a different mineral.

Both processes alter the chemical composition of the sediments and, correspondingly, the composition of the remaining seawater.



UNUSUALLY LARGE INCLUSION containing concentrated seawater (center, with bubble) appears in this sample of rock salt from the stratigraphic level of the WIPP facility 2150 ft. below the ground. Large inclusions, like this one measuring several millimeters on a side, permitted the brine to be extracted from individual inclusions and analyzed by standard wet chemical techniques.



SALADO FORMATION, the geological site of the WIPP repository, consists of three parts: an upper unit (from 255 m to 405 m below the surface) composed primarily of halite (rock salt), including some thin beds of polyhalite, anhydrite, and halitic sandstone; the middle unit (405 m to 520 m), a potash zone containing, in some regions, economic deposits of sylvite and langbeinite; and a lower unit (from 520 m to the Salado-Castile contact at 851 m) consisting primarily of thick halite beds in which the repository is located at a depth of 645 meters (1250 ft.) below ground surface. The Salado Formation, the Castile Formation (below it), and the Rustler Formation (above it) together represent a typical marine evaporite sequence: The thick halite and anhydrite units of the Castile Formation constitute the deep-water portion, with the Salado and Rustler Formations comprising shallow-water deposits.

“Unfortunately,” notes Jim, “we can never know the exact nature of processes and conditions that operated in the past.”

“But a record of those processes is preserved in the brines,” he continues. “We can look to the brines themselves and to the rocks that make up the Salado Formation [see drawing] for clues to what those processes were.”

### ‘Reading’ the Rocks

Once sediment has consolidated into rock, there is no way of knowing its exact composition before consolidation. But the chemical reactions active during its formation may be inferred from its present mineral composition. The composition of the rock can also be “read” for clues to chemical reactions that occurred in the brines while the rock was forming.

These chemical reactions, according to Carol and Jim, may account for the varying compositions they observed in the samples of brine from the WIPP site.

Carol and Jim suggest that during this stage of the geological history of the Delaware Basin, extremely concentrated seawater — with a composition typical of present-day seawater during late-stage evaporation — reacted with certain minerals in the sediment to produce brines with the varying compositions they observed.

The rocks at the repository site today are composed of thick layers of halite — mainly sodium chloride, but with minor amounts of anhydrite (calcium sulfate), magnesite (magnesium carbonate), polyhalite (potassium-magnesium-calcium sulfate), quartz, and magnesium-rich clays.

One of these minerals, polyhalite, may be a clue to processes that altered the compositions of some of the inclusion brines.

### First Clue: Polyhalite

Jim and Carol suggest that the compositions of the group of inclusion brines enriched in magnesium and depleted in sodium and chlorine could have been altered when late-stage, highly concentrated seawater reacted with calcium sulfate minerals in the sediment to form polyhalite.

Polyhalite forms when highly concentrated seawater reacts with calcium sulfate. Anhydrite, a logical source of calcium and sulfate, is finely dispersed throughout the thick beds of halite at the repository site.

The reaction involved in the formation of polyhalite affects brine chemistries significantly. In this reaction, twice as much potassium as magnesium is consumed (from the reacting brine), so the result is

## Delaware Basin: A Sea-Change

If you were to stand in the barren desert of the Delaware Basin southwest of Carlsbad, you'd find it difficult even to *imagine* the roar of the sea. But if, through a bit of wizardry, you could be beamed back in time 250 million years or so, you'd need to take a boat with you. You would find yourself in the middle of a shallow sea stretching from horizon to horizon.

Then, if you could accelerate the passage of time so that every minute equaled, say, 500 years, you could witness the tropical sea being transformed to today's arid desert.

You would watch seemingly endless cycles in which the seawater evaporated rapidly in the increasingly arid climate, and then was replenished by influxes of water from the open sea.

By the time you had spent a month of 500-year minutes watching the sea, it would have completely evaporated, leaving thick layers of salt. In another nine months of 500-year minutes, you'd see these salt beds buried more than two thousand feet below ground. That's today's WIPP site.

Captured in the salt are droplets of seawater.

Paradoxically, the very salt that now cradles these tiny droplets of brine — the dehydrated remnants of the long-vanished sea — was itself once gently rocked by that sea — suspended in its sunlit waters.

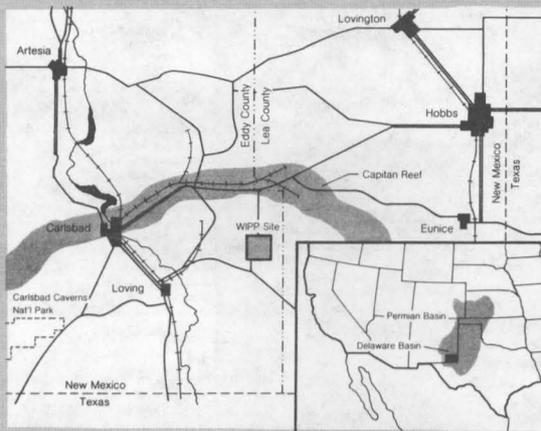
It was like this:

Hundreds of millions of years ago, the shallow sea that had been shifting back and forth across the central and western portions of the North American continent began a long, slow retreat westward.

### One Great Continent

(Of course, the North American continent wasn't then the North American continent. It was still part of one of the large land masses destined to become today's continents. But hundreds of millions of years ago, those land masses were still huddled together as one great continent — Pangaea — surrounded by a single world sea.)

Toward the middle of the period geologists have dubbed "Permian" (280-230 million years ago), the sea had withdrawn to the area of the Delaware Basin in what is now southeastern New Mexico and western Texas (see drawing). But it remained connected to the global sea through



THE DELAWARE BASIN in southeastern New Mexico and western Texas (inset) was once a shallow inland sea. Although it has not been occupied by the sea for more than 200 million years, it remains a topographic basin. Today you can stand in its center and view the Capitan Reef, layers of limestone in the Guadalupe Mountains that rim the basin (shaded band in larger map). These layers of limestone are the remains of ancient banks or reefs that formed around the margins of the sea during the Permian Period (280-230 million years ago).

a narrow channel to the southwest — much as the Mediterranean is connected to the Atlantic through the Strait of Gibraltar.

During the next millions of years — probably in response to fluctuating global sea levels — the sea advanced across the land, retreated, and then advanced again . . .

With each retreat, the land was left dotted with isolated lagoons. During the long intervals between advances, the water in these lagoons evaporated at a rapid pace in the increasingly arid climate.

Then, slowly but inexorably, global sea levels began to drop steadily, reaching their lowest point near the end of the Permian period.

The narrow channel connecting the basin to the open sea became almost completely blocked, and the Delaware Basin was converted from a Mediterranean-type gulf to a shallow, nearly land-locked sea.

As the sea was reduced to a tenth of its original volume — as it probably was many times between waning influxes of fresh seawater — sodium and chlorine in the water crystallized into

salt and fell to the bottom to form loosely packed sediment.

As evaporation continued, the basin at times probably resembled the Bonneville Salt Flats in Utah's Great Salt Lake Desert.

### 'Mud' Beneath Surface

On those salt flats, whirling winds whip the loose, dry surface into salt devils. But beneath the surface, past several inches of sand-sized salt particles, is a creamy, custard-colored "mud" — a mixture of sodium chloride and other minerals precipitated from a sea now shrunk to little more than a lake. Mixed with these are a variety of minerals, clays, and debris washed or blown in from the shores.

The evaporating sea in the Delaware Basin must also have left thousands of square miles of such mud.

In time, this mud would begin to dry out and become buried under successive layers of sand and debris carried across the basin by moving sand dunes and dust clouds. Finally, it would solidify to become the bedded rock salt of the Salado Formation.

But before this happened, even before the sediment became very deeply buried, chemical processes would begin that would work remarkable transformations — calcium would be transformed to magnesite, gypsum or anhydrite would be transformed to glauberite and then to polyhalite — transformations no less rich and strange than those that transform a long-buried tree trunk into the colorful, opalescent phenomenon we know as petrified wood.

And here, too, while the sediment still lay close to the surface, sodium and chlorine — elements once suspended in the waters of the now-vanished sea — would continue to combine, crystallizing into salt. Droplets of the seawater would become trapped in some of the growing salt crystals.

In these crystal sepulchres, the tiny droplets of seawater would lie entombed for hundreds of millions of years — while great mountain chains were built up and worn down and built up again, while reptiles and mammals and birds evolved, and while Pangaea split apart to form separate continents and new oceans.

### (Continued from Preceding Page)

a brine enriched in magnesium and depleted in potassium — a ratio consistent with ratios Carol and Jim observed in one of the groups of inclusion brines.

### Second Clue: Magnesite

Another mineral in the repository rocks, magnesite, may be a clue to processes that altered the compositions of the second group of inclusion brines (depleted in magnesium relative to potassium with higher concentrations of sodium and chlorine).

Magnesite forms when magnesium in highly concentrated seawater reacts with calcium carbonate. Sediments deposited earlier in the evaporative process almost certainly contained calcium carbonate from any number of sources — from material washed in from the seaward margin of the basin or blown in as caliche dust from the shores.

As concentrated seawater came into contact with calcium carbonate, magnesium (from the brine) may have gradually replaced the calcium, transforming calcium carbonate to magnesite.

Unlike the reaction between concentrated seawater and anhydrite, which increases the concentration of magnesium, this reaction decreases magnesium concentration, producing a brine enriched in potassium relative to magnesium — a ratio that matches the ratios found in the second group of inclusion brines.

Carol and Jim suggest, then, that before the sediment in the Delaware Basin consolidated to form the rocks now at the WIPP site, it contained varying amounts of calcium sulfate and calcium carbonate.

When brines reacted with these minerals, transforming them to polyhalite and magnesite, respectively, the composition of the brine in proximity to the reacting mineral grains changed accordingly.

Droplets of these brines were then trapped in salt crystals when the salt grains recrystallized. (Salt recrystallizes to form larger crystals identical in composition to original grains due, partly, to pressure from the weight of overlying layers of sediment; the pressure also causes gypsum to transform to anhydrite, liberating minute amounts of water from the crystal structure of gypsum. In this case, the water may have mixed with the already altered brines, which were then trapped in the growing salt crystals.)

Because all the inclusions from which Carol and Jim extracted brine samples occur in recrystallized salt containing polyhalite, they infer that entrapment of the brines occurred before or during the formation of polyhalite.

Dating of the polyhalite — at more than 200 million years — by Douglas Brookins (UNM Geology Dept.) confirms that this entire process, the alteration of the compositions of the brines and their entrapment in the recrystallized salt (where they remain today), occurred in the final stages of the evaporation of the water in the Delaware Basin.

But only part of the brine in the sediment was trapped in salt crystals.

### Clues in Crystals

The compositions of the brines Carol and Jim collected from weeps and boreholes may have been altered by processes involved in the formation of oth-

er minerals.

Clues to these processes may be the sub-micron-sized crystals of quartz appearing in clays throughout the halite at the WIPP site.

Carol and Jim found that, though the compositions of the brines they collected from weeps and boreholes vary somewhat, they are remarkably similar. Brines in both groups show a more pronounced shift toward increased potassium concentrations than do inclusion brines containing similar sodium and chlorine ratios.

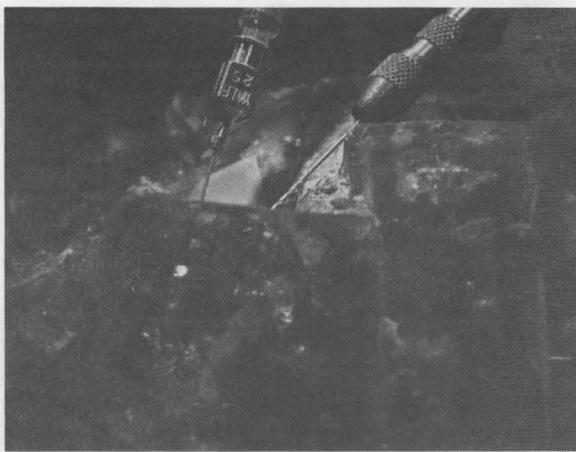
"Overall," says Carol, "the range of weep compositions and their similarity to the borehole brines suggest that both these fluids are intergranular in origin."

That is, these brines were never trapped in salt crystals. Instead, throughout their history they remained free to react with clays and other minerals lying between and around the large chunks of recrystallized salt.

Clays found in association with these brines are unusual in that they are enriched in magnesium but depleted in aluminum over that expected in clays typical of the region.

The mechanisms possibly responsible for depletion of magnesium in the brines and a corresponding enrichment of magnesium in the clays (and depletion of aluminum) are complex. They involve, first, uptake of magnesium from the brine by the clays. This reaction may cause movement of aluminum from the crystal structure of the clay in a man-

(Continued on Next Page)



**EXTRACTION OF BRINES** from the inclusions involved drilling into the inclusions with an extremely small, hand-held drill (right). Powdered salt was continuously removed to prevent fluid loss into the powder by capillary action. Once the inclusion was punctured, the fluid was extracted with a syringe fitted with a 25-gauge stainless steel needle (left). The fluids were then injected into small pre-weighed bottles and diluted to a sufficient volume for a complete chemical analysis.

**(Continued from Preceding Page)**

## Brines

ner that displaces silica; this silica dissolves in the brine and then precipitates as clear, colorless quartz crystals.

The net change in the brine — depletion of magnesium relative to potassium — is consistent with the ratios Carol and Jim observed in the weep and borehole brines.

The time required for these transformations depends on sedimentation and burial rates, temperature, and other variables. So these reactions can take from a few million years to a few tens of millions, or even hundreds of millions of years.

### Important Implications

Important implications of the compositional diversity described by Carol and Jim concern the movement, or migration, of the brines throughout their geological history.

If the compositions of the inclusion brines were altered, as Carol and Jim suggest, during the formation of polyhalite and magnesite, these brines need not have moved more than a few tens of feet. Moreover, dating of the polyhalite suggests that even this movement occurred soon after the sediments were deposited — over two hundred million years ago.

Similarly, the extremely long times required by the processes thought to be responsible for altering the compositions of the weep and borehole brines suggest that weep brines are compositionally and genetically distinct from the inclusion brines — that they have remained segregated from the inclusion brines for millions of years. The variations observed by Carol and Jim among their samples of weep brines also suggest that the weep brines themselves have not homogenized throughout their long geological history.

These compositional differences argue against the hypothesis that brines from the inclusions have, through some mechanism, escaped entrapment and become mixed with the weep brines — or that they are the source of the weep brines.

Overall, the failure of the brines to homogenize during the millions of years since their compositions were altered from that of ordinary seawater argues against the existence of an interconnected hydrologic system that could effectively transport nuclear wastes away from the repository.

Is large-scale, albeit very slow, movement of the brines occurring within the repository?

“We don’t have enough evidence yet to state unequivocally that slow, large-scale brine migration is not occurring,” says Carol.

“But,” adds Jim, “two facts — the diverse compositions of the brines and the long periods of time required to attain that diversity — support arguments against such large-scale, slow brine movement in the salt at the WIPP.” ●DR



SUSAN REESE (daughter of Bob, 7544) was a participant in the White House Conference for a Drug-Free America held in Washington, D.C. Feb. 28-March 3. She’s shown here with conference chairman Lois Haight Herrington and her husband, DOE Secretary John Herrington. A junior at Sandia High School, Susan presented her paper, “Youth’s View and Expectation of the Family,” for the Drug Abuse Prevention Committee Panel at the conference. (She was the only teenager on the panel.) Her presentation stressed the importance of the family — as a place for learning values and as a support group — in the battle against drug abuse.



“SUN DOGS” such as this one, captured on film Feb. 25 by Bob Hughes of Photometrics and Optical Development Division 7556, most often occur over the Albuquerque area during the winter months, according to astronomy expert Grover Hughes (ret.). The bright spots of light, usually tinged with color and positioned close to a solar halo (visible here), are often seen in pairs: one each to the left and right of the sun, and one each straight above and below. Sun dogs are caused by the refraction of sunlight through ice crystals suspended in the atmosphere. Bob shot the photo with a 35mm camera, using a 28mm lens; exposure was 1/125 sec at f/11 on ISO 100 color negative film. Object in foreground is a fence post.

## feed back

*Q. Our directorate is no longer supporting the major function of our division. Seven MTSs were directly involved. It was requested that some of us find work elsewhere and that some of us stay but change our work function significantly. This is not, of course, a rare phenomenon. But I have two questions:*

*1. Is there an official avenue for us to find new positions, such as individual “Situations Wanted” postings in the Weekly Bulletin or the LAB NEWS?*

*2. If not, why not; and can such a procedure be initiated to help employees in situations like ours?*

A. Several approaches are available to employees, not only in the situation you describe, but to any employee whenever he or she needs assistance with personnel-related activities. The most visible alternative is the *Weekly Bulletin*, which provides a readily accessible source of information regarding current position openings that may interest you. The

*Weekly Bulletin* explains the self-nominating procedures and lists all current non-represented vacancies with a description of the position duties and qualifications.

The closest thing available to a “Situations Wanted” column, and perhaps the most valuable resource available to you when dealing with personnel matters, is your Personnel Representative. Personnel Reps are available to provide assistance with locating a new position, provide counseling, and in general to serve as a consultant in personnel-related activities. The Personnel Reps are not only aware of what is happening in their own vice-presidencies, but apprise each other of possible openings in other areas as well. Personnel Reps and the organizations they represent are included on the Small Staff page of the Sandia phone book.

Ralph Bonner - 3500

## Medical Corner

# 'Get Fit' Returns

Get Fit New Mexico returns to Sandia the week of March 20. Following close on the heels of Eat Right New Mexico, Get Fit is HealthNet New Mexico's second in its series of three behavior change programs.

The 10-week Get Fit program offers a Get Fit Kit as a tool for behavior change. The kit, modeled after health education materials developed by the Stanford Center for Research in Disease Prevention, provides instructions for developing a physically active life-style through aerobic-type exercise.

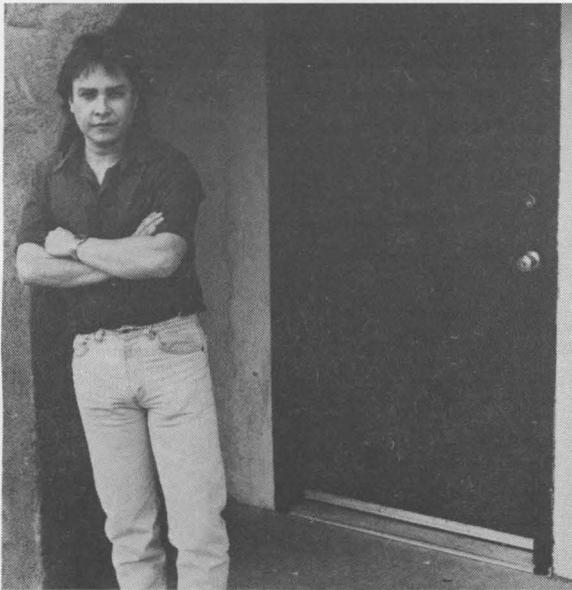
The kit includes tips on how to warm up properly, how to monitor exercise heart rate, and how to track aerobic activities on an exercise log. People who are already actively exercising can expand their activities within the structure of the Get Fit Kit.

So mark on your calendar:

**GET FIT SIGNUP**  
March 23 or 24 or 25  
7:30-9:45 a.m.

Bldg. T-13 (south of Medical)  
Registration Fee — \$5 checks only  
(Payable to HealthNet)

You'll receive the Get Fit Kit, an exercise log, and lots of encouragement. If you finish the program, you'll receive a Get Fit T-shirt and a Get Fit enamel lapel pin, and you'll qualify for a drawing for other prizes. For more information, call 4-8238.



**BOB PADILLA (6447)** OPENED HIS DOOR to the homeless of Albuquerque. He loaned a one-bedroom unit in his apartment complex to a homeless woman and her young daughter. "I hope that my example will encourage other landlords to do the same," he says. To find someone who needed a temporary home, Bob and Dirk Dahlgren (6440), who manages the apartment complex, contacted area charities. They found a woman who had to leave her child at All Faiths Receiving Home because they were homeless. "They've been in the apartment since January," says Bob. "I'm really satisfied with the way this has worked out." Bob plans to loan the apartment for three months. "She's looking for work now," he says. "Maybe she'll stay on as a tenant."



**PRESIDENT REAGAN'S** Scientific Advisor (and Director of the US Office of Science and Technology Policy) Bill Graham (rear) was briefed on Sandia's treaty verification technologies by Roger Hagenruber (9000), Paul Stokes (9110), and John Holovka (9111) last week. Here, John shows him the control room inside the TOSI (Technical On-Site Inspection) facility.

## Community Focus

# Apache Resistance: Fight for Survival

Cochise, Geronimo — fierce and proud Apache chieftains, both.

They and other lesser-known (but just as determined) Apache leaders sparked a quarter-century confrontation between their people and US military forces in the American Southwest a little more than 100 years ago (1861-1886).

From the Apache standpoint, the fight was for survival — of their land, their culture, and their freedom to move about (as this nomadic people tended to do). The Apache domain extended over what is now east central and southeastern Arizona, southwestern Colorado, southwestern and eastern New Mexico, western Texas, and — in Mexico — northern Chihuahua and Sonora states.

Southwest history expert Richard Ellis chronicles "The Apache Resistance" in a Community Focus talk next Monday, March 14, at noon in the Technology Transfer Center. He'll describe the historical events leading to the final surrender of Geronimo in 1886 and the subsequent imprisonment (in Florida) of the Chiricahua Apaches — perhaps the most nomadic and aggressive of all the Apache tribes west of the Rio Grande.

"The Chiricahuas — even those who took no part in Geronimo's raids — were prisoners of war for some 27 years," says Ellis. "Some of the Chiricahuas living today were born as POWs in Florida." (He'll describe their reactions to the Florida experience during his talk.)

### Current Film Project

Ellis, director of the Center of Southwest Studies at Fort Lewis College (Durango), will also discuss a current film project with which he's involved.

The film provides a historical record of efforts by the Chiricahua to retain possession of their land and of their traditional tribal rights. It's being pre-



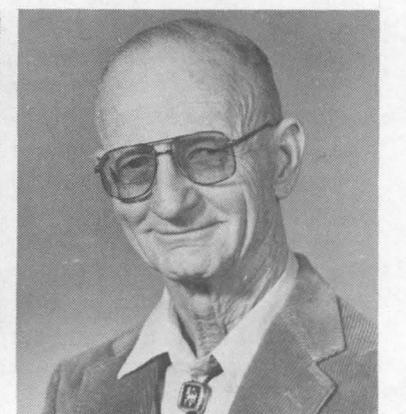
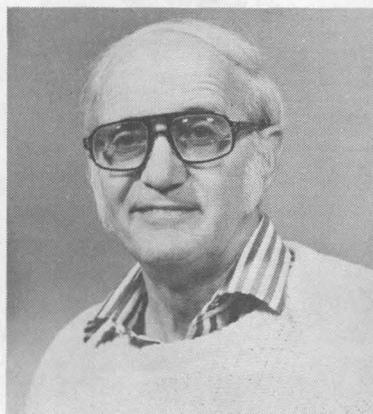
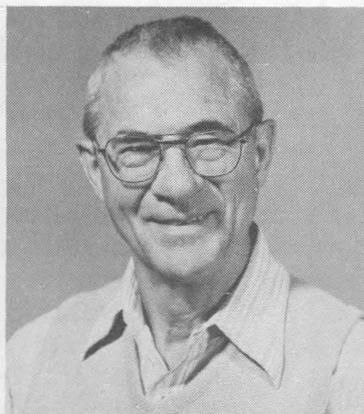
**SOUTHWEST HISTORY EXPERT** Richard Ellis will discuss "The Apache Resistance" at the next Community Focus presentation on March 14.

pared for public television station WGBH in Boston, and is supported by a grant from the National Endowment for the Humanities and the New Mexico Arts Council.

Before he moved to his present job at Fort Lewis College, Ellis taught history at UNM from 1968 to 1986. He was named outstanding teacher of the year there in 1978, and received the Dorothy Woodward Award for Outstanding Teaching from the Historical Society of New Mexico in 1984.

The author of many publications on Southwest history, he's an associate editor of the *Red River Valley Historical Review* and a member of the board of directors of the Historical Society of New Mexico.

## Retiring



Pat Anderson (7522) 37 yrs. Everett Dow (5233) 37 yrs. (DMTS, 5233) 31 yrs. Mary Fischer (7818) 36 yrs. Harry Mason (5238) 33 yrs.

# Supervisory Appointments

CORDELL (SKIP) REEDER to supervisor of Construction and A/E Purchasing Div. 3722, effective Feb. 16.

Skip joined Sandia in June 1979 as a construction services buyer in Purchasing Div. 3721. In 1980, he transferred to Purchasing Div. 3726.

In 1983, he went to Livermore on temporary assignment to the Procurement Division. He returned to Albuquerque in 1984 as a buyer in Computer Procurement Div. 3723. In 1985, Skip became supervisor of Construction and A/E Section 3722-1.

He has a BA in business administration from Utah State University and an MBA from the University of Utah.

In his spare time, Skip enjoys running, cycling, and cooking. He and his wife Ruth have four children and live in the NE Heights.

\* \* \*

ERNEST BRICKELL to supervisor of Theoretical Computer Science Div. 1423, effective Jan. 16.

Ernest joined the Labs in July 1981 as a member of the Applied Mathematics Division, where he did mathematical research in cryptography. In 1984, he broke the iterated knapsack cryptosystem invented by Ralph Merkle and Martin Hellman.

In 1985, Ernest joined Bell Communications Research in New Jersey, where he conducted mathematical research in theoretical computer science. He returned to Sandia in January.

Ernest has a BS in mathematics from Oklahoma State University, and an MS in computer science and a PhD in mathematics from Ohio State Univer-



SKIP REEDER (3722, left), ERNEST BRICKELL (1423), and TERRY MICHALSKE (1134)

sity. He is a member of the American Mathematical Society, and is editor-in-chief of the *Journal of Cryptology* of the International Association for Cryptologic Research.

In his spare time, Ernest skis and plays piano and organ. He and his wife Celia have one son. They live in the NE Heights.

\* \* \*

TERRY MICHALSKE to supervisor of Surface Science Division 1134, effective Dec. 16.

Terry has been a member of the Ceramics Development Division since he joined Sandia in Sep-

tember 1981. His work has focused on mechanical properties of ceramics.

He has a BS in ceramic engineering and a PhD in ceramic science, both from Alfred University (Alfred, N.Y.). Before joining the Labs, he worked at the National Bureau of Standards at Gaithersburg, Md.

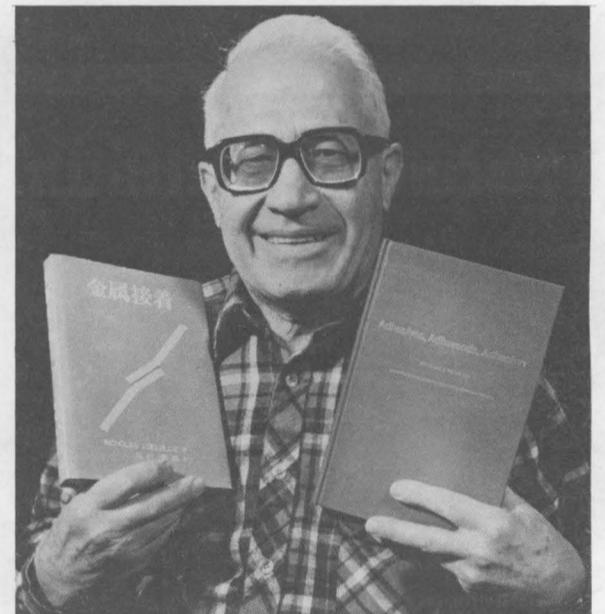
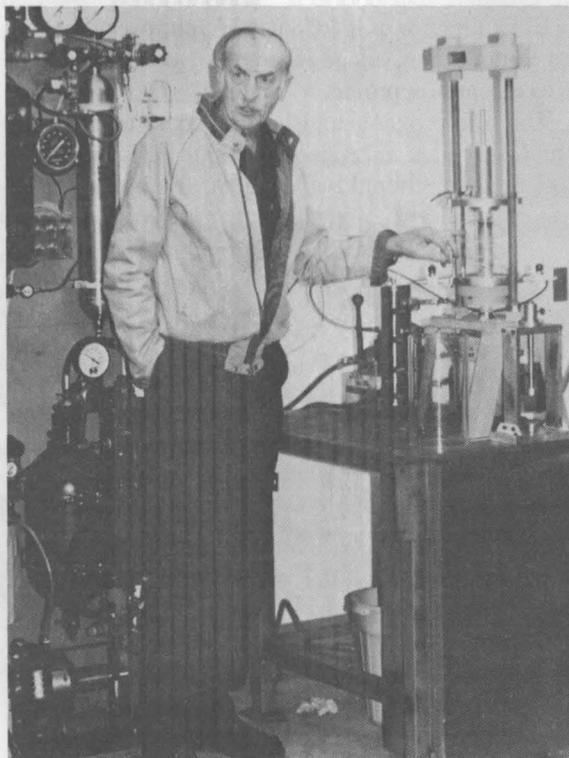
Terry is a member of the American Ceramic Society and the Materials Research Society.

He enjoys skiing and sailing in his spare time. Terry and his wife Susan have one daughter and live in Cedar Crest.



ALBUQUERQUE LAWYER Ruth Pregonzer (center), who spoke at a recent program sponsored by the Women's Program Committee, compares notes beforehand with her sister, Arian Pregonzer (1231, left), and Women's Program coordinator Margaret Harvey (3510). A large audience in Bldg. 815 heard Pregonzer discuss the New Mexico Community Property Act of 1973 and reproductive rights under the US Constitution. A videotape of the program is available from Margaret.

LOU BAUDOIN (ret.) built this triaxial soil-testing machine for NM Tech's Mining, Environmental, and Geological Engineering Department in Socorro. The machine — hydraulic, with strain gages and pressure transducers to measure soil strength in three dimensions — allows engineers to determine, for example, the load-bearing strength of soil columns used as mine roof supports, or how deep bridge pilasters must be to support the weight of the bridge and its traffic. Commercial soil-testing machines run \$30,000; Lou built this one with \$2000-worth of materials and parts from the NM Tech and Sandia salvage yards. He retired in 1978 after a 23-year career in design definition and moved to Socorro two days later. "It's still undiscovered as a retirement town," he notes. "But with people from the school, White Sands Missile Range's Stallion Site, and the Very Large Array, it's an ideal home for a technically oriented retiree."



RETIREE NICK DELOLLIS STUCK to the book-writing business after he retired. He's holding copies of his latest book, *Adhesives, Adherends, Adhesion* (Robert E. Krieger Publishing Co.), and the Japanese translation of his first book, *Adhesives for Metals — Theory and Technology* (translated by Masuo Fukumura, published by Kindai Henshu Publishing Co). His latest work is intended as a sourcebook for production engineers, and is a more comprehensive treatment of adhesives; it also contains sections on wood, ceramics, and plastics. In addition to books, Nick has published more than 50 papers on adhesives, and is a member of the International Standards Organization Technical Committee 61 on Plastics. The book is available from Holman's, Inc., or call Nick on 299-5384.

## Congratulations

To Mary (2132) and Rex (9223) Kay, a son, Phillip Raymond, Feb. 10.

To Debra Azar and Tom Cabe (2312), married in Albuquerque, Feb. 13.

To Rachele and Daniel (1556) Barnette, a son, Taylor Austin, Feb. 18.

To Mary and Lee (1524) Peterson, a son, Geoffrey Colin Lee, Feb. 19.

To Priscilla and Larry (6314) Costin, a son, Alon Edwin, Feb. 22.

# Take Note

In appreciation for Ken Prestwich's (1240) contribution to Texas Tech University's recent Pulsed Power Short Course, a one-year, \$500 student scholarship was established. It's called the "Kenneth Prestwich Pulsed Power Scholarship."

\* \* \*

The Alliance for the Mentally Ill is sponsoring a series of programs on mental illness. Each session will be led by a different authority on the following

topics: March 17 — "Schizophrenia and Major Affective Disorders"; March 29 — "Treatment of Mental Illness: Medical, and Holistic"; April 5 — "Treatment of Mental Illness: Case Management and Psycho-social Rehabilitation"; April 19 — "Coping Skills for Families and Consumers"; May 3 — "Resources for Helping," "Legal Support Groups," and "Crisis"; May 17 — "Resources for Helping," "Advocacy and the Political Process," and "Finan-

cial." Meetings will be held at the Recreation, Health, Occupation Center (617 Truman NE). Materials will be available; programs are free. For more information, call Bill Speyrer on 298-2946 or Emma Duco on 294-3534.

## Sympathy

To Bernice Vigil (2831) on the death of her son in Albuquerque, Feb. 15.

### UNCLASSIFIED ADVERTISEMENTS • UNCLASSIFIED ADVERTISEMENTS • UNCLASSIFIED ADVERTISEMENTS • UNCLASSIFIED ADVERTISEMENTS

**Deadline: Friday noon before week of publication unless changed by holiday. Mail to Div. 3162.**

#### Ad Rules

1. Limit 20 words, including last name and home phone.
2. Include organization and full name with each ad submission.
3. Submit each ad in writing. No phone-ins.
4. Use 8 1/2 by 11-inch paper.
5. Use separate sheet for each ad category.
6. Type or print ads legibly; use only accepted abbreviations.
7. One ad per category per issue.
8. No more than two insertions of same "for sale" or "wanted" item.
9. No "For Rent" ads except for employees on temporary assignment.
10. No commercial ads.
11. For active and retired Sandians and DOE employees.
12. Housing listed for sale is available for occupancy without regard to race, creed, color, or national origin.

#### MISCELLANEOUS

B&W TV, 19", \$30 OBO. Kawola, 298-5813.  
 CUP WARMER, Dazey CW-10, for coffee or soup, desk or countertop, on/off switch, never used, \$4. Schkade, 292-5126.  
 OPEN STOCK TRAILER, w/ramp, load gate, & windscreen, high sides, single axle, rigged for 2 horses or general hauling, \$450 OBO. Asprey, 296-6673.  
 DOUBLE BED: mattress, box spring, frame, \$95. Weiss, 821-8256.  
 GLASS FIREPLACE SCREEN, Sears, 38" x 26", \$15; Sears fireplace heat exchanger, \$15; Presto convection oven, \$20. Schmiedler, 292-6965.  
 PIONEER AM/FM RECEIVER, 50-watt, w/preset stations, equalizer, CD player, Bose interaudio speakers, \$500 OBO. Seth, 275-3875.  
 ZENITH COLOR TV, 17", remote, w/wheeled stand, 11 yrs. old, \$75. Barr, 821-5870.  
 QUEEN-SIZE WATER BED, 6-drawer pedestal, waveless mattress, used 3 times, \$200. Hinrichs, 292-3672.  
 LOUVERED SUNSHADE for rear window of '79-88 Mustang hatchback, \$40 OBO. Abbin, 296-7678.  
 TRUMPET, Mercedes II, case, mouthpieces, etc., serious buyer only, \$250. Gage, 293-1707.  
 BOWLING BALL, Columbia 300, urethane, 14 lbs. 5 oz., 2 months old, cost \$100, asking \$60. Roach, 296-0432.  
 LA-Z-BOY RECLINERS: 1 for \$100, 1 for \$75; 2-level Formica coffee table, \$20. Patrick, 265-4569.  
 SUPER-SINGLE WATER BED, padded rails, footbench, mattress pad, set of sheets, \$190. Radtke, 291-9817.  
 DOUBLE KITCHEN SINK, stainless steel, w/washerless faucet and spray attachment, \$25. Robinson, 865-7787.  
 HP-41CX CALCULATOR, \$100; Yamaha tennis rackets: YFG50, graphite/fiberglass, \$40; YFG30, fiberglass, \$25. Terhune, 292-0736.  
 BEDROOM SET: oak solids/veneer, dresser w/mirror, chest, headboard, frame, double mattress set, \$400. Hammond, 821-1055.  
 CARBINE, .30-cal., \$85 OBO; Miranda 35mm camera, 200mm, 150mm, 28mm lenses, 2x converter, \$300 OBO; toilet, \$5. Grafe, 291-9692.  
 SEARS WOOD LATHE, bench, full set of tools, face plate, 12" x 36" capacity, \$300. Smith, 892-8633.  
 SKI BOOTS, downhill, woman's size 7, \$10; pair of auto wheel ramps, \$10; folding fireplace screen, \$10; WE phone, \$12. Dippold, 821-5750.

AKC COLLIE, female, sable & white, 1 yr. old, all shots & license, \$275, terms. Rhoden, 293-5301.  
 BABY CRIB, changing table, high chair, car seat, swing, other items. Hunter, 865-5745.  
 RABBIT HUTCH, \$12. McRee, 898-5030.  
 BLACK & DECKER ELECTRIC MOWER, 18", w/bag, 3 yrs. old, cost \$150, sell for \$75. Schofield, 292-7220.  
 RGB COLOR MONITOR, CGA made by Texan, \$195; 4-drawer letter file cabinet, tan, \$25; Smith-Corona electric adding machine, \$20 OBO. Adams, 881-4351.  
 AMEREC 610 ROWING MACHINE, \$150. Maloney, 821-6661.  
 TIRES, M/S, E78-14, 2 ea., \$30/pr.; tire chains, fit 14" tires, other sizes too, \$22/set. Cook, 869-6921.  
 CRAFTSMAN SABER SAW, develops 1/2-hp, \$20. Rhoads, 298-6157.  
 APPLE II+, disk drives & controller, 16K board, Apple Dumping-GX & TV interface, paddles, shift key & lower case mods, some software, \$690 OBO. Church, 299-2175.  
 NUTONE RANGE HOOD, 42", \$30 OBO; cast-iron double kitchen sink, \$15 OBO. Cilke, 296-3665.  
 DRAFTING TABLE w/drafting machine, \$100; 35-lb. target recurve bow, w/case and 12 arrows, \$25. Hickman, 296-6989.  
 LAWN TRACTOR, 1986 model, 12-hp OHV engine, electric start, 38" deck, 6-spd., attached rear catcher, two 30-gal. buckets, \$1190. Bassett, 898-1840.  
 BRAZIL CONTEMPO OAK FURNITURE: sofa table, \$150; coffee table, \$250; display center, \$450; sectional, \$450; 25" console TV, \$350. Baca, 299-4875.  
 BUNK BED, solid pine, walnut stain, 2 mattresses, \$200. Olbin, 275-2681.  
 CAB-OVER CAMPER, 8-1/2', all options, \$2600. Tucker, 877-9282.  
 WHIRLPOOL WASHER, 3/4-size, apt. roll-around, 2-spd., 4-cycle, white, \$50. van Berkel, 897-2541.  
 8' CONTEMPORARY-STYLE COUCH, removable cushions. Shapiro, 821-9316.  
 GUILD 12-STRING GUITAR, stays in E pitch, hardshell case, \$375. Foty, 268-0412.  
 ANTIQUE BUFFET, oak, \$600; oak dining table and chairs, 2 leaves, \$700; 1-carat woman's diamond ring, \$1100. Haines, 298-4194.  
 THULE RACK SYSTEM for gutterless cars, locking rails w/cycle mount, new, \$75. Pelzman, 828-1868 leave message.  
 ANTIQUE DAY BED, white wicker, w/mattress and bolsters, \$150; porch swing, \$12. Peterson, 256-7514.  
 ENCLOSED CARTOP CARRIER, Sears; beginner's 16" sidewalk bicycle, w/training wheels. Rodacy, 293-2668.  
 SAILBOARD HULL, Vinta 365, concave, w/straps, centerboard, \$450; 3-piece aluminum mast, \$110. Ritchey, 298-4311.  
 THREE-PERSON EUREKA BACKPACKING TENT, 7' x 9' floor, 6' ceiling, separate rain fly, 9-1/2 lbs. total weight, no cuts or tears, \$100. Connor, 268-9497.  
 NORGE UPRIGHT FREEZER, 16-cu.-ft., \$95. Brock, 299-2934.  
 MAGNAVOX COMPACT STEREO SYSTEM, tuner, cassette, turntable, output level indicators (L & R), dust cover, speakers, \$90 OBO. Herther, 298-4823.  
 WOOL PLUSH AVOCADO CARPET, 20' x 24'; 2 avocado shag pieces, 12' x 19'; oyster, 12' x 17', \$1-\$3/yd. Montoya, 884-5174.  
 PANASONIC WV-3240 VIDEO CAMERA, autofocus, zoom, programmable, adjustable electric viewfinder, w/playback, \$400. Alexander, 291-

8028.  
 RADIO-CONTROL SAILPLANE, 11-ft. wingspan, 4 channels, Futaba radio, \$350. Gibson, 344-8056.  
 SPORT COAT AND SUIT, from Stromberg's, young man's size 36 long. Perkins, 293-9231.  
 DRILL PRESS, CTT Industrial, 12-spd., 3/4-hp, 5/8-inch chuck, \$105; stereo receiver, Pioneer, 60-W, \$50; speakers, walnut veneer, \$35/ea. Denney, 268-0004.  
 HOT TUB OR WOODSTOVE GIFT CERTIFICATE, worth \$1050, will trade for \$950 cash. Baumgardner, 243-0789.  
 EXECUTIVE DESK, 2-pedestal, metal, 4-drawer, \$50; Sears belt massager, \$25. Pace, 299-5036.  
 TANDY 1000 PC, w/dual disk, monochrome monitor, NLQ printer, surge protector, Deskmate and PFS Write software, \$700. Bushmire, 294-2054.  
 HOT TUB, 4-person, portable, complete, w/blower and 2-spd. pump, 110VAC, \$950 or make an offer. Hudson, 298-3935.  
 SEMI-CAB-OVER CAMPER for LWB, gas stove, sink, 17-gal. water tank, icebox, electricity, \$500 OBO. Clingan, 275-0849.  
 SOFA & LOVE SEAT, plush velour, rust-colored, \$400/set or \$300 & \$200. Beckmann, 296-1829.  
 CAMPER SHELL, 1/2-cab-over, paneled, insulated, carpeted, drapes, cost \$950, sell for \$550; 8' camper, \$1300. Burns, 293-2517.  
 "BYTE" MAGAZINES, complete back issues, Vol. 1-Vol. II. Dauwe, 822-8281.  
 SAILBOARD, Mike Shea custom, 9'7", hull only, \$225 OBO. Healer, 298-6967.  
 FOUR MUD/SNOW TIRES, 31x10.50-15LT, \$60. Golden, 299-1274 leave message.  
 PIANO, Simpson & Son studio spinet, \$450; 7' sofa, earth tones, \$150; easy chair, Flex-Steel, w/ottoman, \$85. Newman, 299-6018.  
 ANTIQUE WASHSTAND, oak, \$95. Barr, 281-1858.

#### TRANSPORTATION

HONDA PA-50 MOPED, w/side and front baskets. Jacklin, 298-3046.  
 '86 YAMAHA TT350 TRAILS MOTORCYCLE, \$1350 OBO. Loesch, 299-9477.  
 HONDA 750 SUPERSPORT, 3.1K miles, recently tuned at M&M Honda, \$950 OBO. McCoy, 821-2509.  
 '78 FORD ZEPHYR, 2-dr., 70K miles. Burton, 275-3875 after 5.  
 '83 PACE ARROW MOTORHOME, 34', loaded, \$32,000 retail, \$24,000 wholesale, asking \$28,000. Pullen, 291-0666.  
 '83 DATSUN STANZA, 47K miles, AT, cruise, stereo AM/FM, 4-dr. hatchback, \$3450. Gage, 293-1707.  
 '83 MAZDA RX7-GSL, 40K miles, cruise, AC, auto-reverse stereo w/equalizer, leather interior, more, \$6800 firm. Benecke, 255-1356.  
 '81 DATSUN 210, 5-spd., AM/FM cassette, \$1900 OBO. Turner, 877-5649.  
 '74 HONDA CIVIC, hatchback, \$300. Brady, 828-2262.  
 '83 YAMAHA 920, \$1600. Piatt, 293-1204.  
 BICYCLE, Nishiki International, CrMo, double-butted 25" frame, alloy wheels, completely reconditioned, adult-ridden, \$110. Dippold, 821-5750.  
 '80 PONTIAC BONNEVILLE, 2-dr. coupe, AC, AT, PS, PB, V-8, AM/FM radio, \$1850. Sebrell, 821-4227.  
 '74 SUZUKI TC 185 MOTORCYCLE, streets & trail, 7.2K miles, \$395 OBO. Adams, 881-4351.  
 SCHWINN WORLD 12-SPD. MAN'S

BIKE, 30" frame, 27" wheels, sized for 5'5" to 5'9" rider, \$75. van Berkel, 897-2541.  
 '83 YAMAHA VENTURE XVZ/1200, 10K miles, maroon, extras. Adams, 821-9079.  
 '77 OLDS. CUTLASS SUPREME, new upholstery and carpet, AM/FM tape, \$2000 OBO. Jaramillo, 344-3957.  
 '74 OLDS. 98, \$900 OBO. Kureczko, 298-1577.  
 '78 CORVETTE, AT, PS, PB, AC, rebuilt L82 engine & transmission, mirror & regular T-tops, \$8700 OBO. Duggan, 881-0515.  
 CENTURION 10-SPD. BIKES, one 21" and one 23", used 3 months. Schreiber, 281-3016.  
 '86 BAYLINER BOAT, 14', w/custom canvas cover, AM/FM marine cassette, 50-hp force w/power tilt, trailer, life jackets, \$4000. Henry, 831-3099.  
 '75 FORD MAVERICK, 2-dr., 260 engine, PB, PS, AC, AT, 56K miles, \$875. Hole, 255-1444.  
 10-SPD. BIKE, \$40. Peterson, 256-7514.  
 BMX MONGOOSE 20" BIKE, custom frame, chrome & red, freewheel, thornproof tires, \$120. Connor, 268-9497.  
 '73 OLDS. 98, 4-dr. sedan. Kindschi, 256-0531.  
 '74 MONTE CARLO, V-8, AT, AC, PS, PB, 76K miles, one owner, new tires, \$1250 OBO. Neidigk, 293-0286.  
 '85 OLDS. CALAIS, 4-cyl., 5-spd., cruise, AC, AM/FM cassette, 21.9K miles, one owner, \$6400. Benavides, 897-1317.  
 '80 FORD XLT PICKUP, Supercab, LWB, PS, PB, AC, AT, dual tanks, cruise, 351 V-8, 75K miles, \$2750. May, 821-3846.  
 '77 VW BEETLE, new carburetor and starter, \$1800 OBO. Konopka, 275-0960.  
 '87 DODGE RAIDER, 4-WD, 5-spd., AC, 12K miles, \$10,000. Setchell, 281-5600.  
 '75 TOYOTA CELICA GT, 5-spd., AC, AM/FM, \$795. Copus, 294-4943.  
 '84 CHEV. K5 BLAZER, Silverado package, loaded, AC, AT, PW, PL, cruise, \$1000 under book, \$8500. Bottomly, 344-2137.  
 '78 FORD FAIRMONT, 4-cyl., 2.3-litre, 4-spd., 2-dr., PS, PB, 75K miles, \$850. Boucheron, 298-5835.  
 '85 MITSUBISHI MIRAGE LS, 5-passenger, 5-spd., 25K miles, AM/FM cassette, undercoated. Thompson, 296-1654.  
 '79 YAMAHA DAYTONA, '75 Yamaha RD-350, '72 Husquarna 250CR. Lachenmeyer, 268-7475.  
 '86 MAZDA RX-7 GXL, loaded, sunroof, leather, 5-spd., 21K miles, \$12,900. Pletta, 281-4277.  
 '84 NISSAN MAXIMA SW, loaded, cassette, cruise, OD, new tires, sunroof, complete maintenance record, \$6200. Burton, 869-2541.  
 '83 CHEV. PICKUP, 4-WD, AC, PS, PB, long bed, 4-spd., 25K miles, \$8800. Burns, 293-2517.  
 '80 FORD FAIRMONT SW, AT, AC, PS, 6-cyl., \$1000 OBO. Paez, 293-4677.  
 '64 FLEXLINER, 35' coach, 8V71 engine, 5-spd., partial-function conversion, \$23,000. Cunningham, 344-9841.  
 '78 BUICK CENTURY, PS, PB, AC, AM/FM cassette, V-6, \$1050 OBO. Garrison, 821-6859.  
 '85 S10 BLAZER, 4x4, 2.8L V-6, 33K miles, below book, \$8200. Sloan, 292-1494.  
 '87 NISSAN MAXIMA GXE, 4-dr., AT, leather, power sunroof, digital instruments and locks, auto temp., will consider trade. Brooks, 299-1884.  
 '81 PONTIAC GRAND LeMANS, 4-dr. sedan, brown, never parked at a mall. Cosden, 881-1412.  
 '76 HONDA 750, Windjammer fairing,

saddle bags, trunk, 2 helmets, all color-matched, \$600. Carlton, 268-7275.  
 '83 HONDA CR-480, \$850 OBO. Healer, 298-6967.  
 WOMAN'S 10-SPD. BIKE, Raleigh, \$75. Chirigos, 298-3837.

#### REAL ESTATE

5 ACRES, near Moriarty, \$1800/acre. Lake, 888-4581.  
 3- or 4-BDR. HOME, 1-3/4 baths, 1802 sq. ft., 2-car garage, in-ground pool, \$125,000. Martin, 897-2647.  
 5-BDR. HOUSE, 2408 sq. ft., 3 baths, wet bar/rec room, full basement, Juan Tabo/Menaul, Eldorado HS, fruit/shade trees, shed, \$89,900. Asprey, 296-6673.  
 3-BDR. HOUSE, near Lomas/Morris, 1152 sq. ft., finance options available, \$65,900. Thomas, 293-0681.  
 2-BDR. MOBILE HOME, '88 Palm Harbor, 16' x 81', den, shingled roof, custom-ordered, located in Meadowbrook, \$1000 down, qualify for \$360/mo. Sargent, 828-1460.  
 1-BDR. ADOBE CONDO, apple trees, country setting, acequia, 1 mile above Bishop's Lodge. Calek, 897-4038.  
 3-BDR. PRINCESS JEANNE HOME, 1-3/4 baths, new roof, 1-car garage. Kureczko, 298-1577.  
 3-BDR. HOFFMAN BRICK HOME, Candelaria/Moon area, 1-3/4 baths, covered patio, recently reroofed, new furnace & water heater, \$78,500. Stueber, 299-2414.  
 TWO PARCELS OF COLORADO LAND, Sangre de Cristo Ranches: 7.5 high-country acres, aspen forest, meadow, road access; 5 acres at lower height, panoramic view, access, water, power; owner financing. Wolfer, 415-846-1478.  
 3-BDR. ROBERSON HOME, NE Heights, corner lot, 1600 sq. ft., 1-3/4 baths, hardwood floors, \$84,000. Copus, 294-4943.  
 2-BDR. HOME, den, 1 bath, remodeled kitchen, detached garage, workshop, west of State Fairgrounds, 1270 sq. ft., \$67,500. Hudson, 298-3935.

#### WANTED

"STANDING LIBERTY" QUARTERS, 1916-1930, single coins or collections. Abbin, 296-7678.  
 CHEST-TYPE FREEZER, w/flash-defrost feature, must be in good working condition. Hovorka, 299-0224.  
 YARD ROCKS. Grafe, 291-9692.  
 ADULT BICYCLE for tall male. Frames, 344-6451.  
 BABYSITTER, mature woman to babysit 9-month-old boy on occasional Fri. or Sat. evenings, approx. 6-10 p.m., Central/Carlisle/Lomas area. Foty, 268-0412.  
 LEAD SHOTGUN SHOT OR BALLAST, size 6 through 9, any quantity at 40¢/lb. Connor, 268-9497.  
 DRESSERS; wooden dining room table at least 8' long. Essenmacher, 865-7066.  
 ELECTRIC CONSOLE ORGAN, good condition. Montoya, 884-5174.  
 VHS-FORMAT CAMCORDER to rent, first week of April. Turnage, 265-3720 after 6.  
 BICYCLE HELMET. Bauhs, 281-2688.  
 HOUSESITTER, responsible, for week-end of March 24 through 27. Chirigos, 298-3837.  
 NONSMOKER TO SHARE 2-BDR. HOUSE, near Pennsylvania and Indian School, \$225/mo. plus utilities. Golden, 299-1274 leave message.

#### SHARE-A-RIDE

LOOKING FOR ANYONE interested in carpool from Santa Fe. Wall, 6-3475.

## Irish Eyes Are Smilin' — Come Out and Celebrate!

THE GREEN LIGHT'S ON for everybody to join in the fun at the St. Pat's party on March 17. Celebrating starts right after work in the lounge. Enjoy traditional Irish fare of green chile stew (how much more traditional can you get?), corned beef and cabbage, and chips with salsa — and the food is free. (Any Scotsmen in the crowd?) Everybody's favorite Irishman, Bob O'Banks, entertains at the piano from 5 to 7 p.m. Toast Bob and the rest of the clan with 50-cent draft beer or specially priced other drinks (including cerveza verde, of course).

BIG-BAND SOUNDS from Don Lesmen and crew mean enchanting entertainment tonight as you dance the evening away from 8 to 11 p.m. Beforehand, get "in the mood" at the two-for-one special dinner; entrees are prime rib or scallops. Reserve your dining space by calling the office (265-6791).

SCHUSSBOOMERS SELECT Board of Directors officers at the next Ski Club meeting next Tuesday (March 15). Socialize from 7 to 7:30 p.m., when the meeting kicks off.

Ski trips this month include Taos (March 13-14) and Purgatory (March 18-20).

SAGEBRUSH-SHUFFLE STOMPIN' is what it's all about at Western Night on March 18, right after the two-for-one special (New York steak or snow crab). Those wild-'n'-woolly Isleta Poor Boys belt out the c/w music that night from 8 p.m. to midnight. Be sure to make your chow-line reservations early.

IT'S ALL GREEK TO ME — and to you too, when you head for Greek Night on Saturday, March 19 (and watch out for people bearing gifts!). Start the festivities with a feast (served from 6 to 9 p.m.) featuring lamb, chicken, and fish dishes — all Greek recipes, naturally. The Roland DeRosa Orchestra plays for dancing from 8 to 11, with a break for a flashy floor show by the Palamakia Dancers at 9. This one's bound to be a sellout, so better call in that reservation right now.

### Close to Retirement?

Laurie Saucier of A. G. Edwards & Sons discusses "Building Your Personal Retirement Financial Plan" on March 18 at 5 p.m. in the Eldorado room.

Fred Lancaster of New York Life Insurance Co. presents another discussion on retirement planning on March 21 from 5 to 6:30 p.m. in the Eldorado room. He'll cover a couple of R.I.P. choices for retirement: "Retiring in Paradise" and "Resting in Peace." Phone your RSVP to Fred on 883-5757.

A BUNCH OF CARDS (alias T-Bird sharks) get together for fun and games on March 24, starting at 10:30 a.m. Here's your chance to show off your shuffle and enjoy free refreshments at the same time.

SPEAKING OF BUNCHES, the brunch bunch gets back in the swing of things on Sunday, March

20, from 10 a.m. to 2 p.m. Start off with a complimentary glass of champagne or wine, then dig into some delicious delights: Denver (mile-high?) omelets, carved turkey, ham, spaghetti with meat sauce, green chile stew, tossed salad, assorted desserts, and more. Remember, your membership card gets you a discount (up to \$2) on this treat for the whole family.

THOSE FREE-WHEELING ROADRUNNERS (T-Bird RVers) head south of the border this month (March 20-26) — to Puerto Peñasco (Sonora, Mexico) on the Sea of Cortez. For more info on this "south-to-Sonora" sojourn, contact wagon masters Duane Laymon (822-1749), Tom Brooks (344-5855), or Joe Shelby (292-4605).

BRUSH UP YOUR C-W SKILLS at Western Night on Thursday, March 24. Stomp lessons are scheduled from 6 to 7 p.m., and the Trio Grande Band (is that name for real?) plays for dancing from 7 to 10. Free munchies and special prices on drinks all evening.

WHY DON'T YOU DO RIGHT (like the other folks do — when they sign up for those glorious getaways sponsored by the C-Club Travel Committee). Coming up:

*British Isles (May 17-June 1)* — \$1585/person (double); price breaks on triple and quad occupancy. Deposit of \$150 required; balance due April 1.

*Laughlin, Nev. (April 29-May 2)* — \$162/person (double), \$152 (triple), and \$147 (quad).

## Events Calendar

March 11-12 — Classical Concert VII, New Mexico Symphony Orchestra, conducted by Neal Stulberg; music of Berlioz, C.P.E. Bach, and Morton Subotnick (world premiere); 8:15 p.m., Popejoy Hall, 842-8565.

March 11-13 — "The Seven Deadly Sins" by Kurt Weill, and "Cakewalk," presented by Southwest Ballet Company; 8:15 p.m., KiMo Theatre, 294-1423.

March 12-13 — "Selections from Great Ballets," New Mexico Ballet Company presentation; 8 p.m., Albuquerque Little Theatre, 884-9443.

March 13 — Canterbury Concert Series: chamber music by the Helios Quartet; 4 p.m., St. Thomas of Canterbury Episcopal Church (425 University NE), 247-2515.

March 18 — Concert, Chamber Orchestra of Albuquerque, featuring works by Albuquerque composer Michael Mauldin, Vincent d'Indy, Howard Hanson, and Erik Satie; 3 p.m., St. John's United Methodist Church (2626 Arizona NE), 881-0844.

March 18-19 — UNM Percussion Ensemble, featuring compositions by Max Roach, presented by New Mexico Jazz Workshop; 8:15 p.m., Rodey Theatre, 255-9798.

March 18-April 10 — "Betrayal," Harold Pinter play about love and deception among three friends; 8 p.m. Fri.-Sat., 6 p.m. Sun.; Vortex Theatre (2004-1/2 Central), 247-8600.

March 19 — "Quintessence — Choral Artists of the Southwest," conducted by John Peed; music of Brahms, Mendelssohn, Bruckner, Rossini, and Offenbach; 8:15 p.m., St. Mark's on the Mesa Episcopal Church, 821-0309.

March 20 — Fine Arts Music Series: "The New Swingles Singers," British vocalists; 4 p.m., First United Methodist Church (4th & Lead SW), 243-5646.

March 20 — Sinfonietta/Choral Series V, New Mexico Symphony Orchestra conducted by Roger Melone, all-Bach program including the Branden-

burg Concertos No. 4 and No. 2; 3 p.m., Simms Auditorium, (Albuquerque Academy), 842-8565.

March 23 — Keller Hall Series: Evelyne Brancart on piano, all-Chopin recital; 8:15 p.m., Keller Hall, 277-4402.

March 23-April 3 — "The Road to Mecca," by Athol Fugard, drama about an aging South African woman who finds herself in conflict with her friends and community, presented by New Mexico Repertory Theatre; 8 p.m. Mon.-Sat., 2 p.m. matinees Sat. & Sun.; KiMo Theatre, 243-4500.

March 24 — "Banish Misfortune," combination of troubadour songs of the Middle Ages and Renaissance, Irish reels, and jazz-flavored improvisations; 8 p.m., South Broadway Cultural Center, 848-1320.

March 24-April 3 — "My Fair Lady," Albuquerque Civic Light Opera Assn.; 8:15 p.m. Thurs.-Sat., 2:15 p.m. Sun.; Popejoy Hall, 345-6577.

March 25-April 10 — "Educating Rita," alcoholic English literature tutor meets hairdresser hungry for education; 8 p.m. Wed.-Fri., 6 & 9 p.m. Sat., 2 p.m. Sun.; Albuquerque Little Theatre, 242-4750.

### Carrying Excess Baggage

 A survey of the inappropriate items that people try to carry as hand luggage on airlines turned up the following items: a large aquarium, antique furniture, complete bicycles, and a small robot. "At times, monitoring and stowing baggage can be a test of a flight attendant's resourcefulness," the magazine *Aviation Week* reports.

*New Scientist*



SPANISH EXCHANGE STUDENTS Marina Gonzalez (left) and Sandra Canelada, along with classmates from Los Lunas High School, recently visited Sandia's Central Receiver Test Facility and also toured the Atomic Museum. Here, Marina and Sandra take a close-up look at the aft end of a Mark 7. Bob Austin (3163) arranged the student tour.