pulse period is 33.095 milliseconds, "as close to the radio period as we could get our equipment," says Dr. Taylor. The width of the pulse is four milliseconds, and there are occasional secondary pulses midway between the primaries. The integrated visual magnitude of the object is 18; the peak magnitude is 15.

There have been reports of optically pulsating pulsars before (SN: 6/1, p. 519; SN: 6/8, p. 546) that turned out later to be mistaken. But the latest observation was soon confirmed independently both by the McDonald Observatory of the University of Texas and the Kitt Peak National Observatory in Arizona.

The Steward Observatory astronomers used recording equipment that takes signals from photomultiplier tubes and adds up waveforms. The optical pulses build up to one-sixth or one-seventh of the Crab nebula background. "When we shift off the location we get nothing," says Dr. Taylor. Every time they move the telescope off and back onto the location, the pulsing phenomenon "repeats on command," he says. Furthermore, since the detecting equipment cannot quite match the frequency of NP 0532's radio pulses, the optical pulses shift progressively with time as they reappear.

None of the theoretical pulsar models now under discussion provides for optical pulses. Though he feels its "a little bit early" to make definite theoretical statements, Dr. Disney says, "it's very surprising we're getting these pulses. Some experts on neutron stars say they should be quite impossible."

The discovery will add a new dimension to the information available about pulsars as well as complicating the theoretical problems. "If we had the spectrum of the light, it would tell us very much about the physical processes of the pulsar," says Dr. Frank Drake of Cornell University, another prominent pulsar watcher. That's a matter of time.

SYNTHETIC RIBONUCLEASE

Opening the enzyme door

Ten years ago Dr. Robert Bruce Merrifield told a colleague that he wanted to make an enzyme. "When he stopped laughing," Dr. Merrifield recounts, "he told me I was crazy."

Dr. Robert G. Denkewalter also wanted to make an enzyme, but kept his ambition to himself until about 18 months ago. He, too, thought friends would call it impossible.

"We wanted to make an enzyme," Dr. Denkewalter declares, "because they are a source of wonder and embarrassment to us as organic chemists." Enzymes, members of the protein family, amaze chemists with their ability to speed virtually all chemical reactions within the body, simply and automatically. "They're embarrassing," Dr. Denkewalter says, "because they can do at body temperature and in simple water solution what we organic chemists can do only with corrosive agents, at high temperatures, with laborious processes."

At least 1,000 individual enzymes are known to be involved in the body's biochemistry, triggering reactions that furnish energy for breathing, heart pumping, nerve transmission and digestion. There are probably more, but for all that are known, and for all that is known about them, fundamental questions about what they are and how they work remain unanswered.

But answers are forthcoming. Undaunted by skeptics' laughter, Dr. Merrifield, working at Rockefeller University in New York with Dr. Bernd Gutte, and Dr. Denkewalter, with Dr. Ralph Hirschmann at the Merck Sharp and Dohme research laboratories in Rahway, N.J., patiently pursued their course. Proceeding independently, each team developed separate methods of accomplishing their task, and simultaneously succeeded in manufacturing the enzyme ribonuclease. Its job is to destroy RNA (ribonucleic acid), the cell's carrier of genetic information, after it has been used.

Ribonuclease was chosen as the target enzyme because it is small, as enzymes go—it is made up of only 124 amino acid units—and because its complete three-dimensional structure was revealed two years ago (SN: 2/4/67, p. 119) by scientists at Roswell Park Memorial Institute in Buffalo and at Rockefeller.

Though the most immediate significance of ribonuclease synthesis lies in new explorations in basic research, its laboratory creation is also, in effect, the birth announcement of a new class of drugs. Neither Drs. Merrifield nor Denkewalter foresee any immediate therapeutic application for their achievement, but they agree that someday it could lead to important new treatments, even cures, of such enzyme deficiency diseases as phenylketonuria (which causes mental retardation), anemias, blood disorders and diabetes.

Only within the last two years have enzymes been used experimentally in disease. One, asparaginase, shows promise in treating childhood leukemia, and another, dextranase, is being studied as a tooth decay preventative. But, as Dr. Denkewalter emphasizes, use of enzymes as drugs is not a simple matter. Before a new generation of drugs even begins to take shape, numerous new discoveries and insights which cannot even be anticipated yet will have to come.

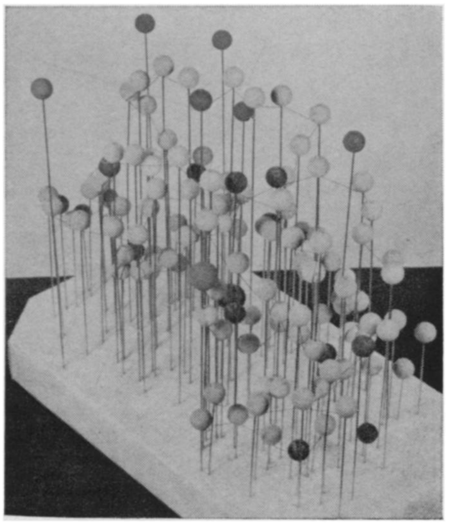
"You can't just make an enzyme and inject it into the bloodstream," he points out. Many enzymes work deep within the interior of a cell. "If you just pour new ones on the outside, the cell couldn't care less."

To make ribonuclease, the Rockefeller scientists used a polystyrene bead .002 inch in diameter as an anchor for the chain-like molecule. Through a series of 369 chemical reactions, performed in 11,931 steps by an automatic enzyme synthesizer working 24 hours a day for three weeks, they linked 124 amino acid molecules together in proper sequence, and then placed it into a solution in which it naturally folded itself into its proper three-dimensional configuration.

The Merck group made ribonuclease in stages, building first one fragment of amino acid molecules, and then another. Then, finally, the bits were hooked together into a linear molecule which, like its Rockefeller counterpart, obligingly took on its three-dimensional shape.

The configuration of the enzyme is essential to its biological activity and its inate ability to put itself in shape confirms a hypothesis proposed by Dr. Christian Anfinsen of the National Institutes of Health that information for the architectural configuration of an enzyme is built into the linear sequence of molecules.

Though the Rockefeller method has the advantage of speed—it is ultimately a month or two faster—the Merck method holds the possibility of manipulating the enzyme by leaving off certain amino acid fragments. That way scientists can test the active sites on the molecule in an effort to see whether or not a smaller, simpler molecule could be designed with equal enzymatic activity.



RNAse—from structure to synthesis.

The synthesis of ribonuclease opens the door not only to further enzyme work but also to synthesis of hormones, a class of chemicals structurally like proteins in many respects.

"Human growth hormone, only 155 amino acids long, has dramatic effects in pituitary dwarfism, for example," Dr. Denkewalter observes. "Someone should make it."

HOLOCAUST PREVENTION

Keeping tabs on quakes

U.S. cities are growing, population is expanding, nuclear power plants are multiplying, oil refineries are enlarging, fuel tanks are proliferating and underground pipelines interlace the country.

But if a strong earthquake were to hit, these same hallmarks of civilization could create holocaust.

And within the next 30 years, the Federal Council for Science and Technology predicts, the country will suffer one great earthquake, a few severe ones and many moderate ones. Dr. William T. Pecora, director of the U.S. Geological Survey of the Department of the Interior, sees the country in a race against time. To Dr. Pecora, the rate of acquisition of knowledge about earthquakes is of vital importance if we are to win.

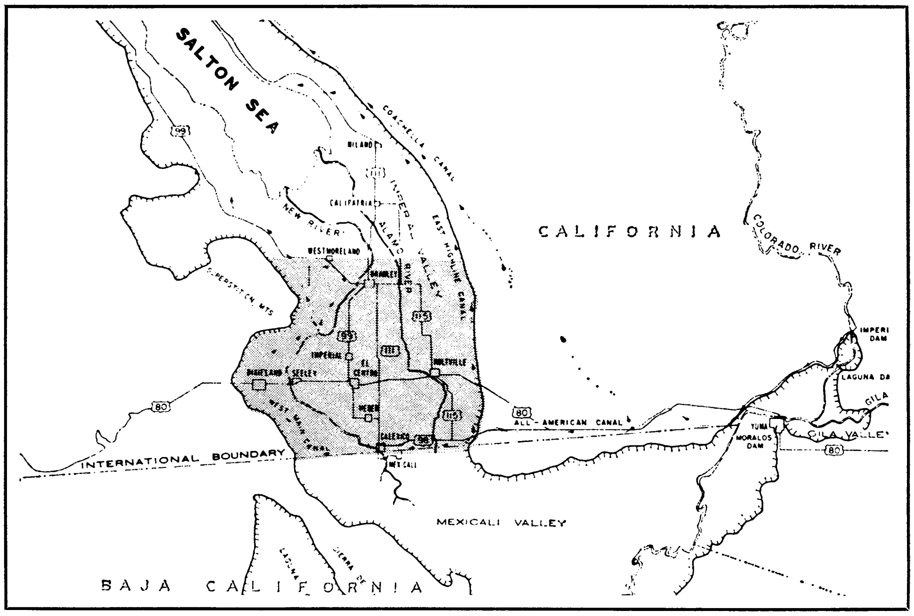
To reduce the expected hundreds or thousands of deaths and the billions of dollars in property damage, an ad hoc group of the council, chaired by Dr. Pecora, proposes that the White House establish a national earthquake research program to find ways to predict not only where but when quakes will strike, how structures should be designed and constructed to ward off the shock, and even what can be done to prevent a quake by relieving stress in the bedrock. The cost of the 10-year program would be about $220 million.

The main obstacle to an effective earthquake program today is not instrument development or lack of scientific manpower, but the money to deploy existing instrumentation and to support associated analyses and research activities. Dr. John DeNoyer, assistant director of research at the U.S. Geological Survey, says, "There are always improvements to be made in instruments, but the present need is for installation of available equipment and research programs to use the collected data."

The largest share of the money, $80 million, would be allocated for development, installation, operation and management of seismic instruments in earthquake zones. The rest would be divided among research in geology and geophysics, the physical nature of earthquakes, and engineering techniques for earthquake protection and prevention.

IMPERIAL VALLEY

Geothermal steam looks better



Geothermal steam fields (shaded area) in Southern California.

Buried under some 2,000 square miles of the Imperial Valley are vast underground reservoirs of extremely hot water (500 to 700 degrees F.) that could supply all the pure water and electric power needs of nearly all of southern California for several decades. The Imperial Valley, extending 70 miles north of the Mexican border and 30 to 40 miles wide, is one vast potential steam field.

Basically, all that's required to make it productive is to drill wells, thereby unlocking the geothermal energy of the water, which would be released in the form of steam. The steam in turn could drive generators to produce electric power. Or it could be condensed into distilled water for agriculture and drinking. The heat from the steam could also be used indirectly to make more distilled water by applying it to seawater, one pound of steam producing 10 pounds of water.

Studies are now being conducted by the University of California at Riverside under the direction of Dr. Robert W. Rex to map out the potential sites for geothermal wells. In a report to be released this month, Dr. Rex will announce the discovery of two new potential sites in the U.S. portion of the Imperial Valley.

The exceptional feature of these fields is their low salinity. High salt content is the spoiler for the wells. If the brine is too salty—20 to 30 percent—it cannot be used for water. The newly discovered well sites contain two to three percent salt, the same amount found in Mexican wells.

To obtain distilled water, a well would be drilled. This releases the pressure, and the extremely hot water flashes into steam. As if in a giant percolator, the water boils at the bottom of the well and sends up steam and slugs of water which are separated by a centrifugal separator, the steam coming out one pipe, the brine coming out another. The hot brine would be carried off to a succession of chambers, each at a lower pressure than the one before to compensate for the lower temperature and still make steam.

The flow rate from the most productive Mexican well, near Mexicali, is two million pounds of steam and brine per hour, or 140,000 barrels a day, the highest flow rate of any well in the world.

There is enough potential energy in the steam fields to end the squabble between California and Arizona over rights to the Colorado River, their common boundary and the major source of water and power in that area (SN: 2/11/67, p. 135). The dispute grew out of historical rights that governed claims to the Colorado River. The result is that today the Imperial Valley alone is entitled to one-third of its share of the river's water. However, if the potential of the steam fields in the Imperial Valley—a truck gardener's paradise—could be realized economically, California would no longer need all of its share of the river.

"The economics of the situation are appealing," says Dr. Rex. "The cost of heat for electricity and desalination would run from one to two cents per one million British Thermal Units, whereas heat from nuclear sources is