versely related to pore pressure, the pressure of fluids in the rock spaces. As the pore pressure increases, rock strength decreases.

Geologists and geophysicists at the National Center for Earthquake Research in Menlo Park, Calif., are considering testing the theory, with an eye to its application in earthquake control. Right now, they are at the data-gathering stage, but within three to four years, they hope to complete field experiments.

One factor favoring the fluid injection method is the nature of West Coast earthquakes. Most of the world's earthquake activity takes place at relatively deep levels, but on the West Coast it is shallow enough to put it within reach of standard drills.

"We are excited about it," says Dr. John H. Healy, geophysicist with the U.S. Geological Survey at Menlo Park. "There is a remote chance that it might be used in the San Andreas fault and a fairly good chance we might try it in a remote section."

There is some evidence that the method can work. At the Rangely oil fields in western Colorado, one of the ways to get oil out of the ground is to pump water into the margins of the oil fields and remove the oil from the center. Seismic activity, in the form of small earthquakes, has been detected.

Dr. Hubbert is very cautious about the method. He feels that the consequences of employing a fluid pressure mechanism could go either way. "The increase of fluid pressure could set off a San Francisco earthquake," he warns, adding that it depends on the amount of stress on the rocks. "If there were little stress build-up, then it could work."

He compares the stress situation to that of a giant mousetrap: "A small act can release the trap. Fluid injection could produce a series of small jolts or set off a big one. Injections should occur at a minimum of stress. If you're going to mess with a mousetrap, mess with it when it's not set."

One other earthquake control idea being considered is the use of explosives to relieve the stress. However, that is not being seriously considered. The scheme would be to place large numbers of explosives in a region under stress. Theoretically, the explosions could break the weak points in the rock, thereby shaking the fault loose a little bit at a time.

But such a method requires extremely precise control; it is very likely to trigger a quake. The magnitude of the explosions required could cause as much damage as the quake. Explosion effects at the Atomic Energy Commission's Nevada test site are being checked to test the method.

HINDSIGHT REVISITED

Payoffs from research

The electron microscope magnifies objects to more than 100,000 times their real size. Studies of viruses, cancer cells and high-strength alloys for spacecraft depend on it. The electron microscope and its related instruments today constitute a $200 million industry. But the machine is not really new; its origins go back to 1858 when cathode rays were discovered and a theory of kinetic mixing of gases was proposed.

Birth control pills, first marketed only nine years ago, trace their heritage to 1849 and the discovery of a hormone. Now they are the base of a $100 million business; millions of women take them regularly.

Applied advances in science, a National Science Foundation study shows, almost invariably depend on a solid base of fundamental knowledge acquired years before ideas for its application are conceived. The study, initiated by NSF in 1967 and carried out by the Illinois Institute of Technology Research Institute, was designed to test scientists' long-held hypothesis that without basic, undirected research there is no progress in applied research.

This study, says NSF director Dr. Leland J. Haworth, "demonstrates the need for a broad base of scientific knowledge to underpin technological progress." The hypothesis backing basic research, he believes, is proved.

Undertaken to provide a systematic evaluation of the role of research in the process of technological innovation —a process that according to NSF cost the nation $24 billion in 1968—NSF and IITRI scientists chose five important advances with major social or economic impact on society and traced their lineage from the first bit of knowledge to ultimate development.

The five are:

- The electron microscope.
- Oral contraceptives.
- The video recorder that gives high quality images and instant replay ability to television.
- Magnetic ferrites, a class of engineering materials used in computers, and television transformers.
- Matrix isolation, a technique for stopping chemical reactions for observation.

Of the key events identified in the life-cycle of each of these developments, approximately 70 percent were nonmission research, "completed without insight into the conception and innovation to which it will ultimately contribute," the report states.

Further, it says, more than three-quarters of that basic work is carried out in universities and colleges, where the number of significant jumps in understanding peaks 20 to 30 years before the innovation. For example, the bulk of experiments in reproductive physiology, hormone research and steroid chemistry that lie behind development of oral contraceptives were performed between 1930 and 1940, though at the time no one was actually aiming toward a birth control pill.

"Innovations for the next generations depend on today's nonmission research," the study concludes, calling for greater Federal expenditures. "If the increase in sophistication is to be maintained, the breadth and depth of research to be supported must also be increased.

TALENT SEARCH

Then there were forty

Forty of the nation's most scientifically acute young people have emerged at the top of the 28th annual Science Talent Search, sponsored by Westinghouse Electric Corporation and administered by Science Service.

The 29 male and 11 female high school students will share $67,500 in scholarships and awards and an all-expenses-paid trip to Washington, D.C., where 10 of them will receive four-year Westinghouse Science Scholarships totaling $60,000. The remaining 30 will receive Westinghouse Science Awards of $250 each. The 10 scholarships consist of one of $10,000, two of $8,000, three of $6,000 and four of $4,000.

The 40 students, high school seniors ranging in age from 16 to 18, were picked by the judges and evaluators from among 21,951 contestants, of whom 2,361 qualified for final selection by taking a science aptitude examination, obtaining recommendations and writing a report on their science projects. The projects were in fields including biology, chemistry, physics, astronomy and mathematics and ranged from the role of X-rays in dentistry to a study of the evolution of the universe and the influence of extreme cold on amplifier circuits with special microelectronic components.

The Science Talent Search is designed to discover and develop scientific ability among high school seniors and is conducted annually for the Westinghouse Science Scholarships and Awards by the Science Clubs of America.

The 40 finalists, by state:

- Alabama—Andrea Jane Yates, Austin High School, Decatur.
- California—William Francis Ganong III, Albany H.S., Albany; Lynne Dianne Calonico, Presentation H.S., Berkeley; J. Edward Jackson III, John F. Kennedy H.S., Richmond, and Allan Dale Pekary, Santa Monica H.S., Santa Monica.
- Florida—John Douglas Whittaker, Nova H.S., Fort Lauderdale and William Thomas Mason III, and Christopher Dean Patrinely of Terry Parker H.S., Jacksonville.
- Idaho—Jennie Marie Orr, Coeur D'Alene Senior H.S., Cour D'Alene.
- Illinois—Richard Norman Weinberg, Bowen H.S., Chicago; Howard Mark Lederman, Roger C. Sullivan H.S., Chicago, and Leslie Robert Cohen of Niles Township H.S. North, and Willy C. Shih of Niles Township H.S., West, Skokie.
- Indiana—James Oscar Scamahorn, Brebeuf Jesuit Preparatory School, Indianapolis.
- Maryland—Justin Craig Schaffert, Springbrook H.S., Silver Spring.
- Massachusetts—Paul Whiting Maloney, North Quincy H.S., North Quincy.
- New Jersey—David Allan Wright, Pascack Valley H.S., Hillsdale.
- New York—Claude A. Raifaizen, Bayside H.S., Bayside; Demetrio Mena Jr., Thomas Jefferson H.S., Brooklyn; Jason Hsu, Forest Hills H.S., Forest Hills; Jeffrey Lawrence Hawryluk, Jamaica H.S., Jamaica; Bret Berner and Barbara Jean Rosenberg of Bronx H.S. of Science, New York; Lida Joan Morawetz, Hunter College H.S., New York; Marilyn Ann Finn, Mother Cabrini H.S., New York, and Robert Joseph Cava, Martin Van Buren H.S., Queens Village.
- Ohio—Anna Tsing Lowenhaupt, Walnut Hills H.S., Cincinnati, and Jill Ann Markwood, Lancaster H.S., Lancaster.
- Oklahoma—Clarence Lapierce Wiley, Manual H.S., Muskogee.
- Pennsylvania—Barbara Ann Baron, Haverford Township H.S., Havertown; James Allen Isenberg, Plymouth-Whitemarsh H.S., Plymouth Meeting, and Michael Avery Kearney, Washington H.S., Washington.
- Texas—Gary Ray Rylander, Stephen Austin H.S., Austin; Lane Palmer Hughston, Hillcrest H.S., Dallas; Gordon James Freeman, Arlington Heights H.S., Fort Worth, and Lane Allen Fusilier, Stephen F. Austin H.S., Port Arthur.
- Virginia—Jack Richard Woodside Jr., W.T. Woodson H.S., Fairfax; Joseph Bell Jordan Jr., McLean H.S., McLean, and Susan Irene Bromberg, Churchland H.S., Portsmouth.
- Washington—Bonnie Gale Cardwell, Joel E. Ferris H.S., Spokane. ◇