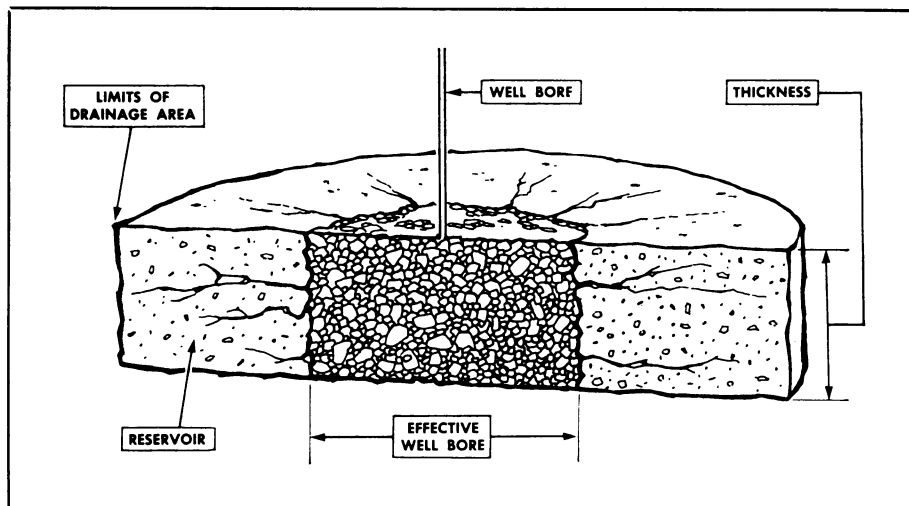


## Plowshare: struggling to live



*A nuclear blast stimulates the flow of natural gas by fracturing bedrock.* Coffer

### The fledgling technology of nuclear engineering is plagued by problems

In 1242 A.D. gunpowder crossed from China into Europe. It took another 300 years for it to grow into its first commercial application in mining.

Project Plowshare, the Atomic Energy Commission's peaceful nuclear engineering program, is only 13 years old, and industry is impatiently insisting that it is ready for its long pants. But problems ranging from technology to money to psychology are holding up the process.

**A major problem** appears to be residual radioactivity, which engineers are finding difficult to remove from the gas, oil or the area surrounding the nuclear blasts. One purpose of the Plowshare experiments was to find out how serious the radioactivity problem would be; indications are that it is serious indeed.

By optimistic reckoning, Plowshare is expected to go commercial in the 1970's. It will not go all at once.

"Pieces and bits will go commercial," says Richard Hamburger, assistant director of the AEC's division of peaceful nuclear explosives. "You don't go commercial on day X."

One look at the number of projects backed up on line is enough to tell why. Their status ranges from detailed, costly plans already being tested, to feasibility studies, to pencil sketches on napkins. They include gas stimulation (Projects Gasbuggy and Rulison), oil stimulation (Project Bronco), mineral recovery, underground storage depots for gas, oil and waste, a canal across Central America, a North African canal, an Australian canal and the release of underground geothermal energy for power and water.

Of all of these, the closest to reality is gas stimulation. The 1967 Gasbuggy



AEC

*Hamburger: Commercial by bits.*



CER Geonuclear

*Dr. Coffer: Gas to market in two years.*

test in New Mexico demonstrated the feasibility of extracting stubborn natural gas by fracturing the bedrock to permit it to flow into a collecting chimney, though the volume was not as great as was hoped, and the principle is still being reviewed.

"Production should have been up more," said Dr. Glenn C. Werth, associate director for Plowshare at the Lawrence Radiation Laboratory, Livermore, Calif., at last week's American Nuclear Society meeting in Las Vegas, Nev., "if fractures played the role that was anticipated."

**Gasbuggy** was not a production test. The 1969 Rulison blast (SN: 9/20, p. 236) in Colorado was, and the results of that test will determine if enough gas can be obtained to make nuclear stimulation economically worthwhile.

But even if it is, that will not be the end of gas stimulation's troubles. Radioactivity, specifically the radioactivity from the hydrogen isotope tritium produced by thermonuclear blasts, will have to be cleared up, although some see it as an emotional or public acceptance problem that has become a tech-

nical one only by extension.

Dr. Henry F. Coffer of CER Geonuclear Corp. in Las Vegas, contends that under the worst circumstances only .03 gram of tritium would be in the hundreds of millions of cubic feet of gas from Rulison, a little less radioactivity than would be received by flying from Las Vegas to New York.

But any contamination is a problem. "It's only contaminated a little bit; well, this is like being only a little bit pregnant," says Dr. J. A. Wethington of the University of Florida. "Something must be done about it."

Dr. Coffer agrees; he says there are three things that can be done:

- The contaminated gas can be diluted with uncontaminated gas.
- The contaminated and uncontaminated gases can be separated.
- The contaminated gas can be piped to a remote area to generate electric power.

Because the first solution still leaves some radioactivity and because the second would be what he considers "quite a technical undertaking," Dr. Coffer favors the third.

The radiation problem is one that nearly all Plowshare projects will have to face. It is even more serious in oil stimulation.

Although 90 percent of the tritium from oil shale can be removed by treatment with heat and moisture, tritium remains a major bugaboo.

Says W. D. Arnold of the Oak Ridge National Laboratory, "Removal of tritium from oil does not appear practical at this time because it appears to be part of the hydrocarbon structure." Because of the radiation difficulty, Dr. Werth says, "progress in oil shale is frankly disappointing."

**Exclusive** of radiation there are some encouraging results from the French oil stimulation tests at their Hoggar site in the Sahara Desert between 1960 and 1962. The French studies show that the geological fractures caused by nuclear explosions can stimulate oil flow 100 times that of conventional means. As presently envisioned, oil stimulation would involve the collection of the oil in a chimney created by the explosion. Then natural gas at the top of the chimney would be ignited, creating a descending front that forces oil to the bottom of the chimney, where a pump could bring it to the surface. But it would be radioactive.

Radioactivity will also pose a problem for the nuclear recovery of minerals such as iron and copper (SN: 11/1, p. 408). Copper, for example, has been shown to be contaminated by an isotope of ruthenium created in the process.

And nuclear excavation projects, such as the sea level canal across the Isthmus of Panama (SN: 11/30/68, p. 549) would vent some radioactivity into the air, thus requiring an amendment to the Limited Test Ban Treaty. The treaty forbids the release of radioactivity across national boundaries.

**Ranking alongside** radioactivity as a problem—and in some cases surpassing it as a barrier to Plowshare's commercial maturity—is economics. Before nuclear gas stimulation can go commercial, its cost must be brought down. The Rulison test cost \$6 million, and Dr. Coffey estimates that this must be brought down below \$1 million. And this can be achieved, he says, by reducing or eliminating expenditures no longer as vital. For example, testing equipment, initial drilling operations and public relations efforts can all be eased. In short, just as with conventional technology, greater sophistication brings down the costs.

If everything breaks right for Rulison, including legal and political obstacles, Dr. Coffey says that there could be a commercial program in about two years.

But legal obstacles were in the minds of many of the 800 scientists, engineers and Government officials from 17 countries in Las Vegas. While they were meeting, Rulison—and by implication, Plowshare—was fighting for its life. The battle continues this week in a Denver court with the American Civil Liberties Union demanding the project be banned because, it says, radiation safety standards are inadequate.

Another problem that has brought public recrimination against Rulison, and which is inherent in nuclear engineering, is seismic shock caused by the blast. But here little if anything can be done. Exploding a one-megaton device underground, a mile from a city, will certainly wreak havoc. If that is where the site must be and if that is the yield required, then the only option is evacuation, something being considered in the case of the trans-Isthmian canal.

#### FISH PROTEIN

### Setback for a supplement

In the search for abundant new sources of food, fish protein concentrate (FPC) has frequently been hailed as one of the more hopeful possibilities for the future (SN: 11/8, p. 428). A nutritious but tasteless off-white powder produced from whole fish, FPC is a supplement that could be added to nearly any prepared food.

Throughout a decade of deepening world food crisis, FPC has been slowly working its way toward practicability and acceptability through the joint efforts of the Federal Government, advisory groups and industry.

Finally, in the fall of 1968, development and testing reached the stage that the U. S. Agency for International Development entered into a pioneering contract with Alpine Marine Protein Industries under which the company was to produce 970 tons of FPC to be distributed abroad. No other company submitted a final bid for the work.

**The high hopes** for that project, however, have been shattered. AID has terminated the contract because only 70 of the first 525 tons processed by Alpine met U. S. Food and Drug Administration standards for high-enough levels of protein content. FPC again suffered a setback.

But the program is far from dead. Alpine is seeking the cause of the protein deficiency. Interior's Bureau of Commercial Fisheries, which pioneered in FPC processing, is helping with that effort, and Interior is seeking regulatory permission to expand the categories of fish usable in the process.

"I don't think there should be any

shrugs one nuclear enthusiast: "It's something you have to live with."

Besides the major technical problems brought about by radioactivity, economics and seismic shock, each Plowshare project will have its own particular problems. Geology may be a hindrance in one, the political climate may stall another, technical difficulties may hamper a third and legal, political, sociological and military considerations may hinder others.

As if all of these troubles weren't enough, Plowshare received the back of an Administration hand, when its 1970 budget was cut in half from \$29.2 million to \$14.5. "The Nixon Administration has seriously crippled the Plowshare Program," charged Rep. Chet Holifield (D-Calif.), chairman of the Joint Committee on Atomic Energy, at the ANS meeting. "We have to live with it," he added stoically. "We have to revise our programs and extend our time goals."

censure attached to Alpine because of this," says Dr. George K. Parman, director of AID's Food From the Sea Program. "In fact I think they ought to be complimented for their bravery." He and other officials emphasize that FPC development is still in the difficult early stages, where temporary failures should not be unexpected.

Of the many problems that afflicted Alpine, the protein deficiency is the most perplexing. "We really don't yet know the cause," says Reginald A. Bourdon, Alpine's Washington, D.C., representative. "Some of the material comes out fine and some of it has a deficiency problem."

Regulations currently specify that FPC be produced from hake or hake-like fish. Hake is a lean fish considered to have a low economic value by a



Bureau of Commercial Fisheries  
*Protein from hake: Bad time for FPC.*