

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.

traditional fishing industry concentrating on high-fat fish like salmon and herring.

A number of FPC processing methods have been developed in recent years, but in all of them the fish is processed without removal of heads, fins, tail, viscera or intestinal contents. In order to obtain a bland-tasting, stable and yet nutritional concentrate, it is necessary to extract water, water-soluble odor-bearing compounds and fats from the raw material. There can be a number of difficulties at this stage since certain of the fats are firmly attached to the proteins.

Most fat extraction processes use only a single solvent to dissolve the fats, in order to minimize the problems of removing the solvent. But since many single solvents are generally inefficient, several FPC production methods use solvent mixtures or solvent sequences.

The process used by Alpine was one of these. Actually Alpine used the technique of the VioBin Corp. of New Bedford, Mass., since it had arranged to use VioBin's processing plant to fulfill the AID contract. In this method ethylene dichloride is used as a first solvent, followed by successive baths of isopropyl alcohol.

The technique perfected by the Bureau of Commercial Fisheries as part of its research effort, in contrast, uses only isopropyl alcohol as a solvent. Both processes were approved in 1967 by the FDA for manufacture and sale of FPC in the United States.

The dissimilarity is one difficulty the bureau is having in trying to help Alpine decide what went wrong. "We are just not as familiar with their process as with ours," says Roland Finch, director of the bureau's National Center for Fish Protein Concentrate. The problem of protein deficiencies had not been encountered in the bureau's method.

It may turn out that the problem with Alpine's product is a result of a still-undiscovered operational factor, rather than of the process itself, although Finch tends to consider that wishful thinking. Evidence seems to point to something about the two-solvent process. Another possibility is that the protein is being damaged by heat during the processing, although the temperatures used seem to be within acceptable constraints. A number of other possibilities are being studied.

"It's an unresolved problem," says Finch, "but I think a systematic attack on it will find the cause."

Alpine plans to reopen the plant at New Bedford on Feb. 1, partly in an effort to help track down the defect in the process. "We are going to try to solve our problems," says Bourdon. He hopes that if the difficulty can be found

and corrected a new contract might be negotiated with AID this spring.

Hope for FPC's future also lies with the petition put before FDA by the Bureau of Commercial Fisheries to allow the concentrate to be made from additional orders of fish, including the families of herring, anchovy, eelpout, right-eye flounder and codfish.

This would help greatly to improve the economic situation for Alpine and future FPC manufacturers. Alpine was hurt by a smaller-than-expected catch of hake in 1968 and 1969 by the New England fishermen who had sub-contracted to supply the necessary tonnage to the company.

Granting of the petition would mean

MARMES MAN

Drying out a discovery

Buried under a few sheets of plastic, some gravel and a lot of water, is one of the best-known archaeological sites in America. Reclaiming it depends on someone coming up with \$7 million.

The small canyon in southeast Washington State, where the 10,000-year-old remains of Marmes Man have been unearthed in the past five years, happens to lie in the path of a man-made lake created recently by construction of a dam on the Snake River. In spite of a protective levee that the U.S. Army Corps of Engineers thought would avert flooding, lower parts of the archaeological site have been under 30 feet of water since early last year. It has been inundated, but not destroyed.

Dr. Roald Fryxell, a Washington State University geologist who took part in the first Marmes discoveries, has been visiting the site periodically and reports that the highly sloped terrain still seems to be in good shape. "So far," he says, "there has been no evident slumping." Whether the Government, educational institutions and foundations will finally scrape together funds to retrieve the land, however, is anybody's guess.

Shortly after the flooding began, anthropologists and geologists from Washington State University met with hydraulic engineers and with Sen. Warren G. Magnuson (D-Wash.). The conferees were enthusiastic about the sheer technical feasibility of removing the water. On the other hand, they agreed that the price tag of \$3 million to \$7 million estimated by the Corps of Engineers meant pumping operations could not possibly begin so long as the Government is trying to restrict its support for scientific projects.

"In effect," says a scientist who was present at the conference, "we decided we'd have to wait until after Vietnam."

that the processor would no longer have to sort out the hake from other varieties that can constitute up to 30 percent of a catch. It would also allow the fishermen to go after more common varieties of fish during the months that hake disappears.

The FDA has until March 15 to take action on the petition, although it can then request another 90 days for additional study.

For the long-run future of FPC, assuming the protein deficiency problem is surmounted, the most important factor is economics. "FPC, to be successful, has to be lower in cost," says Finch. "I think this is feasible with time and experience."



Harvey S. Rice

Dr. Roald Fryxell and Marmes skull.

Marmes may also lose out to recent archaeological discoveries, which have begun to overshadow the more spectacular aspects of the Marmes Man site. When the skeletal remains of Marmes Man, consisting mostly of parietal skull bones, rib pieces and vertebrae, were dated in 1968 (SN: 5/11/68, p. 445) they attracted international attention. The age of 11,000 to 13,000, assigned to the remains by analysis of the overlying strata of mussel shells, was the oldest definite age that had been obtained for human remains in America. Dr. H. Marie Wormington, then president-elect of the Society for American Archaeology, called the Marmes discovery "the most significant development in American archaeology in the last 25 years."

But other human remains that have been analyzed in the last year may be older than Marmes Man. According to Dr. T. Dale Stewart, retired director of the Smithsonian Institution's Museum of Natural History, bones found at Laguna Beach, Calif., "have a good