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## A hundred million dollars' worth of holes

LAST year, at the instigation of Dr Eugene Shoemaker of the California Institute of Technology, about 50 United States geologists, geophysicists and representatives of the drilling industry put their heads together to talk about deep drilling in the Earth's crust for scientific purposes. Not surprisingly, they came out in favour of it. Their proposal, aimed at anyone who will listen, is for a large scale continental drilling programme within the United States and is just published\*. The recommendations are sufficiently wide-ranging and expensive (indeed they have rather a 1960s air to them) to merit a long critical look by the scientific community and some very careful thinking in Washington.

The primary purpose of the Continental Drilling Project (CDP), according to the report, is "to provide a sound scientific base that will aid government in establishing national energy policy and that will assist industry in the discovery and development of new energy policies". Then, a page later, the "objective of the proposed drilling program is not for mineral exploration itself but for scientific data ... helpful to geoscientists in developing sound theories on mineral deposit locations". But then a quarter of the funds are to go to investigations of the nature of faulting and earthquakes—the public safety line. All this in a frantic ten pages of foreword, preface, summary and recommendations and introduction. Clearly the net is being cast wide for potential sponsors.

Holes from 1 to 10 km deep could, it is claimed, make major contributions in at least the following fields:

- Lateral penetration of a fault zone to study near-fault conditions, even with the idea of thinking seriously of earthquake control.
- Drilling into hydrothermal systems and active magma chambers in an attempt to understand their physics and geology.
- Determination of the thermal structure of the Earth's crust.
- Investigation of the state of ambient stress in the crust.
- General studies on the deep geology of the United States.

In addition, a programme of shallow drilling (down to 300 m) is proposed in which three teams sweep over the United States, drilling 500 holes a year for a variety of purposes. This last programme, at \$1 million a year, looks sufficiently sensible (and certainly necessary) to be implemented independently of the success or failure of the rest of the proposals.

What of the remainder—can it be done, should it be done and if so, by whom?

The report makes it clear that drilling to a depth of 10 km in crystalline rock will be pushing technology quite hard. Holes to that depth exist in sedimentary formations (in pursuit of oil), cost up to \$10 million and take up to

\*Continental Drilling (ed. by Shoemaker, E. M., Carnegie Institution of Washington, 1975).

700 days to drill. In hard rock the costs would be comparable and the time required somewhat greater, but costs and times would obviously increase if extensive scientific investigations were carried out simultaneously. The instrumentation requirements for such work demand considerable improvements in temperature protection over present-day equipment. But there do not seem, as far as the technology goes, to be any fundamental obstacles.

Should it be done? The past twenty years have seen some chequered fortunes in major earth-science ventures. (The name of Mohole inevitably springs to mind, but so also does the Joides programme and its successor, the Deep Sea Drilling Project. The report makes only very passing mention of the latter, and none at all, of course, of Mohole.) What emerges clearly is that not all the proposals discussed have equal merit and that it would perhaps be a mistake to try to sell a \$100 million package on the basis that everything fits together. For instance, drilling laterally into the San Andreas Fault might be worth the investment of \$10 million or \$20 million (but it is surely imprudent to talk yet of control), whereas many of the less specific projects aimed at generalities like understanding the underlying structure of the North American continent barely warrant the same attention. It is particularly unfortunate that the whole is tied together with vague claims about energy policy and mineral resources. The veneer which it is necessary to apply to proposals these days is often distinctly thin, if not transparent. A wise decision in Washington would be to be very selective of the pack and to ignore the packaging.

And if support is forthcoming, who will get it? Drilling companies will, of course, and will handily find the government supporting their research and development. On the scientific management front, the division has somehow to be worked out between government institutions, particularly the Geological Survey, and the universities. Giving the lion's share to the Geological Survey will cause a lot of bitterness in the academic world among those who think the survey writes its own cheques, but at least the job will get done. What the survey fears, no doubt, is that it will be entrusted with day-to-day running, with the universities coming in when things get exciting and creaming off all the interesting material.

Finally it is regrettable that in the earth sciences, traditionally most internationally minded, it is now desirable to write a report which barely touches on international collaboration. A paragraph is devoted to mention of collaboration in Iceland. We are told in two lines that the idea (of deep drilling) has been implemented in Canada, West Germany, Japan, South Africa and the Soviet Union. And that is all. If this is a consequence of a growing nationalism in matters of energy and mineral resources, then it is a bad one, and it is to be hoped that any scheme ultimately approved takes note of the international dimension. □