depth of 6000 feet every 2 square miles, for a total of 5 billion feet of exploratory drilling.

By the late 1950's, cumulative exploratory drilling added up to just under 1 billion feet or 20 percent of the necessary total, leaving 80 percent of the rock to be explored—and the same proportion of oil to be found.

With all that oil, Zapp wrote in 1962, shortly before his death, the size of the resource would not limit domestic production capacity "in the next 10 to 20 years at least, and probably [not] for a much longer time."

It is hard to tell just how this optimistic forecast affected federal energy policy during the 1960's. It may have contributed to Federal Power Commission decisions to hold down the price of natural gas, a contributing factor to the present shortage. A 1968 energy policy report by the Interior Department* noted that if the Survey's oil and gas estimates turned out to be too low "we certainly should know about it in time to decide intelligently among the available alternatives."

The report went on, however, to indicate that the Survey's estimates were probably valid. On the other hand, Harry Perry, a Washington energy analyst with long experience in the Interior Department, say the Survey's predictions were generally taken with a grain of salt. "I don't know anyone who used these estimates for planning public policy," Perry says.

They were, in any case, promptly questioned by Hubbert. Writing in a report on national energy resources produced by the Academy in 1962, Hubbert pointed out that Zapp's approach implied that oil had been, and would continue to be, found at a uniform rate per foot of drilling. In fact, "finding rates" had fallen sharply since the late 1930's as oilmen skimmed the cream off the prospects in Texas, Oklahoma, and California. From a high of 276 barrels per foot of exploratory drilling, discoveries have fallen to about 35 barrels per foot by 1965 and to 30 in 1972.

Not until 1965, however, did the Survey concede Hubbert's point. That year, the USGS noted a "definite decline" in discoveries and postulated now that oil would, on the average, prove to be only half—not equally—as abundant in unexplored rock as in explored rock. Now this number is in contention, with Hubbert claiming that it's at least five times too large for onshore terrain. McKelvey acknowledges that the figure of one-half was largely a "subjective judgment" and another official describes it as "mostly a guess."

Hubbert is a man to be reckoned with. One of the Survey's more venerable researchers, he was among the crews that pioneered seismic technology in the Texas oil fields in the late 1920's. Since the late 1940's Hubbert has been refining his own novel technique for estimating oil and gas resources, and along the way he has acquired a reputation as something of an oracle.

In the long run, Hubbert reasons, the oil industry's growth and inevitable decline must follow a roughly bell-shaped curve dictated by a finite resource—first an exponential rise slowing to a peak, then an exponential decline tailing off to zero. The area under the curve would represent total U.S. oil production. Using past records of discovery, reserve growth, and production, Hubbert says that this total will be about 190 billion barrels (of which 143 billion have already been found).

In 1956 this conclusion led Hubbert to a prediction that was almost universally considered outrageous at the time: U.S. oil production, he said, would reach its peak between 1966 to 1971. Perhaps by coincidence and perhaps not, domestic oil production peaked in November 1970 and has slowly declined ever since. Hubbert has also predicted that natural gas production will peak this year or next.

No one disputes that the petroleum industry must inevitably follow some sort of growth-and-decline curve. Says McKelvey, "Hubbert can't possibly be wrong. In time we will reach a peak and start to decline. The question is when."

Hubbert says it happened 3½ years ago, and the Survey's numbers imply a peak sometime around 1985. The pessimistic view reinforces the oil industry's argument for accelerating offshore leasing. But, as energy policy analyst S. David Freeman notes, it also undercuts industry's case for still higher oil prices.

Whoever is right, the implications for energy policy beyond the mid-1980's are the same. The nation will urgently need dependable replacements for oil and gas. In the shorter term, Harry Perry observes, "The difference is whether the next 10 years will be tough or not."

It's possible, of course, to increase production by improving recovery tech-

* *United States Petroleum Through 1980* (U.S. Department of the Interior, 1968).

# NEWS & NOTES

● **PROFS EARN MORE, GROW POORER**: According to a survey carried out by the American Association of University Professors (AAUP), in 1973–1974 for the first time in 16 years college and university professors have lost ground economically. Although the faculty members received compensation increases of slightly less than 6 percent, their real purchasing power eroded by about 1.5 percent. Inflation is said to be the cause of it all. Since the rate of inflation is rising, the economic outlook for faculty members next year is definitely not promising. Copies of "The Annual Report on the Economic Status of the Profession, 1973–74" may be obtained for $2 in early July from Ms. Maryse Eymonerie, AAUP, 1 Dupont Circle, Suite 500, Washington, D.C. 20036.

● **KUDOS FOR ECOLOGISTS**: The first John and Alice Tyler Ecology Award was presented to three scientists this year. The recipients, each receiving an honorarium of $50,000, were G. Evelyn Hutchinson, professor emeritus of zoology at Yale University; Arie Jan Haagen-Smit, professor emeritus of bio-organic chemistry at the California Institute of Technology; and Maurice F. Strong, director of the United Nations Environment Program in Nairobi, Kenya. The award, established by John and Alice Tyler as a result of their avid interest in ecology, will be administered annually by Peperdine University in California. In the future, it is expected that the $150,000 award may be presented to a single recipient.

● **PHYSICAL PHANTASMAGORIA**: Geophysicists in search of new worlds to conquer might do worse than to scan the pages of *Strange Phenomena*, a compilation of unexplained natural events such as the green ray, the Brocken specter, the luminous portents of earthquakes, Barisal guns, and mistpouffers. Apart from brief introductions, the contents consist of original descriptions, many of them drawn from scientific journals such as *Nature*. The compiler, William R. Corliss, is a physicist turned free-lance writer who chose the descriptions on the basis of their strangeness and "their tendency to contradict current scientific hypotheses or stretch them beyond their present bounds." The book is available from Corliss, P.O. Box 107, Glen Arm, Maryland 21057 at $6.95.