

So we need a total mining system. And this can be extremely effective.

Attention should be directed mostly to commodities mined in large volume, where reduction in extraction costs would measurably improve the capacity of domestic sources to compete commercially with sources abroad. I have in mind those operations that produce zinc, iron, copper, and the like; all of these commodities have large, deep resources, and can't be competitively handled today.

A new approach to underground rock breaking, initially tested on December 10, 1967, near Farmington, N. Mex., is the use of nuclear explosives to aid in the recovery and utilization of low-grade mineral resources heretofore uneconomic or impossible to exploit. Potential applications include in situ leaching of copper ore, natural gas stimulation, petroleum production, and the recovery of oil from oil shales. Similarly, attention should be directed to those commodities where lower extraction costs would tend to improve the commercial significance of certain domestic sources or effect important savings when measured against projected demands.

Here, again, are uranium and gold—parenthetically, the gold chemistry is 50 years old. In the last 50 years there must have been some advances in chemistry which can be usefully applied to the gold industry. We have a study program on this at Reno, Nev., under Tom Henrie's direction, and we have found some of the most exciting new gold chemistry that you can imagine. If we can apply this to production it is going to have a tremendous effect.

Also included here are oil shale, most of the industrial minerals including limestone, the natural carbonates, salt and phosphate rock. Considering the future potential of clay as a source of aluminum and gypsum as a source of sulfur, perhaps these should be included, too.

Technical advances will be needed in separation practices, such as preparation, beneficiation, reduction, and smelting, where improved recoveries and cost reductions must be realized to prevent deterioration in the competitive position of domestic sources. Examples include zinc and its byproducts, with particular emphasis on retorting practices; beneficiation of iron ores, particularly flotation practices; copper and its coproducts and potassium in light of the decreasing grades of ore; and molybdenum, in regard to losses in processing, to name just a few. Incidentally, molybdenum is going to be in trouble one of these days for that very reason. We have high production, but we have not achieved the necessary efficiency.

Senator ALLOTT. When you say efficiency in recovery, are you referring back to your remarks about mining a few moments ago, or the reduction processes?

Dr. HIBBARD. No, I am referring to the treatment of the ore.

Senator ALLOTT. You are talking about the treatment of the ore.

Dr. HIBBARD. Yes.

Senator ALLOTT. Thank you.

Dr. HIBBARD. Just how many of these situations that yield competitive superiority will develop during the remainder of this century depends on our willingness to make the research and development commitments necessary for the creation of new technology and also on our aggressiveness in applying that technology once it becomes available.