

mineral resources not now available by any known production techniques, obviously, there is a strong possibility that the development of a successful nuclear explosive technology will also permit lower cost production of mineral resources already being utilized.

National significance

The gradual development of explosives over the years has made possible new and more efficient blasting applications in the modern minerals industry. Since the discovery of black powder, the entire field of explosives technology has steadily improved. Each significant advance has made possible cost reductions that have permitted the economic mining of increasingly lower-grade mineral deposits. The atomic age, now more than two decades old, offers the promise of using the world's most powerful explosive to achieve further substantial economies in producing the mineral raw materials needed by man.

The Interior Department's Bureau of Mines, in cooperation with the U. S. Atomic Energy Commission and private industry, is now engaged in a program of research aimed at utilizing the energy of nuclear explosives to expand our domestic mineral resources base. The success of these cooperative efforts in one or more of the fields of mineral development could add significantly to the reserves of metals, nonmetals, and fuels that can be made available at reasonable real costs.

Criteria for government involvement

Government participation is essential in developing the technology that will permit use of nuclear explosives in the mineral industries primarily because at present, and for many years in the future, the control of nuclear explosives can be expected to remain a government responsibility. Moreover all existing technology, whether for military or peaceful uses of nuclear explosives, has been developed by the government or under close government supervision. Therefore, only the government can furnish the explosive and the technical knowledge for its safe industrial application. Until the government, with the cooperation of industry, has demonstrated that nuclear explosives can be used safely in the minerals industry, the industry will be reluctant to assume the major costs and the responsibility for public safety that are inherent in the use of nuclear explosives.

Nevertheless, it is also clear that any demonstration of the effectiveness of nuclear explosives in industrial application should be jointly undertaken by government and industry, and that each should share a proportional part of the necessary costs of the projects authorized. The government must determine the overall safety aspects of any proposed experiment, and must provide the nuclear explosive and supervise all safety. The technology available should be provided by the government. Once a particular minerals application has been demonstrated to be feasible and safe, the government should withdraw to the extent possible and all similar applications in the future should become the responsibility of the using industry, with the government acting only to insure security and safety.

Preferred course of action

The efficient use of nuclear explosives in the mineral industries depends on: (1) continued research and development in the production and design of nuclear explosives, (2) continued cooperation between government and industry in solving the many problems of industrial application, (3) availability of nuclear explosives for industrial use at reasonable costs, and (4) international acceptance of the Plowshare concept for peaceful use of nuclear explosives; that is, the nations of the world must reach agreement not to prohibit by test-ban treaty, the beneficial use of nuclear devices.

Expected benefits

A brief description of possibilities for nuclear explosives in the mineral industries will point out some of the potentials for this energy source.

Deep underground nuclear explosions usually create large "chimneys" of broken rock, and several potentially valuable industrial applications for this effect can be identified. For example, a nuclear chimney and related fracture zone in underground natural gas bearing rock formations of low permeability could act as a highly effective well bore, which may make it possible to recover natural gas from such formations with far greater efficiency and economy than is now possible. In an oil-shale deposit or a low-grade copper orebody, a nuclear chimney might make possible in-place retorting or leaching operations through which the fuel or metal values could be recovered without incurring the costs inherent in mining and disposal of waste rock. Created in an area regionally near, but