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## Future Supplies of Energy and Minerals

**M**ost past estimates of long-term future demands for energy and mineral resources have been outmoded by events. The projections led to predictions of large unsustainable requirements for energy and to pessimism about the future. The estimates did not adequately take into account the impact of the oil crises of the 1970's in stimulating the use of human ingenuity to adjust to new circumstances.

A Dahlem Conference held in Berlin 12 to 17 January provided the basis for less pessimistic views. At the end of the meeting it was a widely held conclusion that during the next 50 years mineral supplies would probably be adequate for global demands. There was less confidence about energy. It was generally thought that the developed countries could obtain adequate supplies but that the future of the less-developed countries was uncertain.

In the past, one of the major uses of energy in developed countries has been in the winning and industrial processing of minerals. In these countries the manufacture of goods involving minerals now represents a decreasing percentage of the gross national product. Demand for many major consumer goods is near saturation. Requirements for primary materials are being decreased by enhanced efficiency of use, including recycling, better engineering, and advances in manufacturing techniques. Downsizing of automobiles by U.S. manufacturers has led to a decrease in materials consumption by that industry of more than 25 percent in the past decade. Current emphasis on quality control will result in longer lives for products such as automobiles.

Another factor that is decreasing the need for energy while increasing the flexibility of the economy is substitution of, for example, polymers and composites for more energy-intensive materials such as steel. This leads to lighter motor vehicles and further energy savings through less fuel consumption. Substitution is likely to have an important role in reducing dependence on imports of minerals. For example, ceramic matrix composites can replace superalloys that contain such elements as cobalt, chromium, and columbium.

A sufficient number of improvements in efficiency of energy use have occurred so that it seems feasible for the developed countries to raise their standard of living without increasing the use of energy. What will happen in the less-developed countries is not predictable. It is clear that availability of energy alone is not a magical answer. Korea, with practically no indigenous fossil fuel, has experienced a fast-growing economy. Most of the oil-rich less-developed countries have not provided for their future well-being. Some others will probably barely be able to obtain enough food for growing populations.

At the Dahlem Conference a group of leading earth scientists considered the matter of economic minerals from the standpoints of present reserves and probable future discoveries. By reason of improved techniques employing geophysics and geochemistry, explorationists have been able to maintain effectiveness in terms of ore found per unit of effort. In Canada, where massive copper-containing sulfide deposits are being mined, no appreciable decrease in grade has been noted. The often cited drop in grade of copper ore in the United States was attributed to a decision to mine low-grade porphyry ores because of lower costs.

Three frontiers for exploration were cited, including the continental shelves, the ocean deeps, and the continental crust. The probability is high that in the developed countries sizable deposits are present but under cover. As improved exploration techniques become available, future exploration for minerals may tend to occur in developed countries.

The Dahlem Conferences\* are conducted under a formula that makes for good transfer of information and positive interaction of participants, whose number is limited to 48. Before the conference, about half the participants are asked to provide background articles on the topics to be discussed. These articles are distributed well in advance of the meeting so that when participants meet, they can begin discussions on an informed common level. These discussions lead to opinions and conclusions that are brought together with the invited articles to form a book. In the present instance, a second, related conference will be held in late April on water and land. The results will be published either in a single book or as companion volumes.—PHILIP H. ABELSON

\*Dahlem Konferenzen, Wallotstrasse 19, D-1000 Berlin 33, Federal Republic of Germany.