

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Science serves its readers as a forum for the presentation and discussion of important issues related to the advancement of science, including the presentation of minority or conflicting points of view, rather than by publishing only material on which a consensus has been reached. Accordingly, all articles published in *Science*—including editorials, news and comment, and book reviews—are signed and reflect the individual views of the authors and not official points of view adopted by the AAAS or the institutions with which the authors are affiliated.

Editorial Board

1978: RICHARD E. BALZHISER, JAMES F. CROW, HANS LANDSBERG, EDWARD NEY, FRANK W. PUTNAM, MAXINE SINGER, PAUL E. WAGGONER, F. KARL WILLENBROCK

1979: E. PETER GEIDUSCHEK, WARD GOODENOUGH, N. BRUCE HANNAY, MARTIN J. KLEIN, FRANKLIN A. LONG, NEAL E. MILLER, JEFFREY J. WINE

Publisher

WILLIAM D. CAREY

Editor

PHILIP H. ABELSON

Editorial Staff

Managing Editor

ROBERT V. ORMES

Business Manager

HANS NUSSBAUM

Assistant Managing Editor

JOHN E. RINGLE

Production Editor

ELLEN E. MURPHY

News and Comment: BARBARA J. CULLITON, *Editor*; LUTHER J. CARTER, CONSTANCE HOLDEN, DEBORAH SHAPLEY, R. JEFFREY SMITH, NICHOLAS WADE, JOHN WALSH, *Editorial Assistant*; SCHERRAINE MACK

Research News: ALLEN L. HAMMOND, *Editor*; RICHARD A. KERR, GINA BARI KOLATA, JEAN L. MARX, THOMAS H. MAUGH II, WILLIAM D. METZ, ARTHUR L. ROBINSON, *Editorial Assistant*; FANNIE GROOM

Associate Editors: ELEANORE BUTZ, MARY DORFMAN, SYLVIA EBERHART, JUDITH GOTTLIEB

Assistant Editors: CAITILIN GORDON, RUTH KULSTAD, LOIS SCHMITT, DIANE TURKIN

Book Reviews: KATHERINE LIVINGSTON, *Editor*; LINDA HEISERMAN, JANET KEGG

Letters: CHRISTINE KARLIK

Copy Editors: ISABELLA BOULDIN, OLIVER HEATWOLE

Production: NANCY HARTNAGEL, JOHN BAKER; YA LI SWIGART, ELEANOR WARNER; JEAN ROCKWOOD, LEAH RYAN, SHARON RYAN

Covers, Reprints, and Permissions: GRAYCE FINGER, *Editor*; CORRINE HARRIS, MARGARET LLOYD

Guide to Scientific Instruments: RICHARD SOMMER

Assistant to the Editors: RICHARD SEMIKLOSE

Membership Recruitment: GWENDOLYN HUDDLE

Member and Subscription Records: ANN RAGLAND

EDITORIAL CORRESPONDENCE: 1515 Massachusetts Ave., NW, Washington, D.C. 20005, Area code 202. General Editorial Office, 467-4350; Book Reviews, 467-4367; Guide to Scientific Instruments, 467-4480; News and Comment, 467-4430; Reprints and Permissions, 467-4483; Research News, 467-4321; Cable: *Advances*, Washington. For "Instructions for Contributors," write the editorial office or see page xi, *Science*, 30 June 1978.

BUSINESS CORRESPONDENCE: Area Code 202. Business Office, 467-4411; Circulation, 467-4417.

Advertising Representatives

Director: EARL J. SCHERAGO

Production Manager: MARGARET STERLING

Advertising Sales Manager: RICHARD L. CHARLES

Marketing Manager: HERBERT L. BURKLUND

Sales: NEW YORK, N.Y. 10036: Steve Hamburger, 1515 Broadway (212-730-1050); SCOTCH PLAINS, N.J. 07076: C. Richard Callis, 12 Unami Lane (201-889-4873); CHICAGO, ILL. 60611: Jack Ryan, Room 2107, 919 N. Michigan Ave. (312-DE-7-4973); BEVERLY HILLS, CALIF. 90211: Winn Nance, 111 N. La Cienega Blvd. (213-657-2772); DORSET, VT. 05251: Fred W. Dieffenbach, Kent Hill Rd. (802-867-5581)

ADVERTISING CORRESPONDENCE: Tenth floor, 1515 Broadway, New York, N.Y. 10036. Phone: 212-730-1050.

Domestic Exploration for Materials

A civilization with a high standard of living is dependent on adequate supplies of many kinds of materials. Some elements are of critical importance. For example, chromium is an essential component of low-corroding stainless steels. Cobalt is needed to bond diamonds in cutting tools. The United States is dependent on outside sources for supplies of these and more than a score of other elements.

This country began the 20th century with more than its share of easily exploitable domestic resources. American prosperity and assurance of raw materials were reinforced by the results of geologic exploration elsewhere. Therefore, in the 1950's and early 1960's large parts of the world's oil and mineral reserves were owned by American companies. Most of the remaining reserves were under the control of friendly, stable governments. But great changes have occurred. The future of much of Africa is uncertain. American domination of foreign resources has ended. A long-term decline in the grade of domestic ore reserves has continued.

With an economy increasingly vulnerable to disruptions of supplies, with security of supplies uncertain, and with a diminished ability to pay for imports, intensified efforts to lessen U.S. dependence on foreign sources are needed.

Thus far there has been little action by the federal government; on balance, the government has hindered efforts to increase mineral supplies. During the past decade large areas of the most promising public lands have been closed to exploration. Funds available to the U.S. Geological Survey for mineral exploration have been modest. Support from the National Science Foundation for research on mechanisms of ore formation has been small. Industry is active in exploration, but the extent is not readily gauged.

The quest for ore deposits is handicapped by lack of knowledge of how elements are mobilized in the earth. Many of them are present in an average abundance of a few parts per million or less. But when found in ores they may have been concentrated by a factor of 10^4 or more.

Processes relevant to the genesis of ore deposits probably go back to the beginning of the solar system. Apparently this planet was assembled from heterogeneous materials and some of the heterogeneity persists on a large scale. The earth has been a laboratory in which many chemical separations have occurred. The environment of these events has changed with time. The interior of the earth was hotter in early times than it is today. When magmas reached the surface, weathering and subsequent sedimentation occurred in an oxygen-poor atmosphere. The ores in Precambrian rocks differ from those formed later and in general are more valuable. Precambrian rocks outcrop in substantial areas of Africa but form a smaller fraction of the surface of the United States. Surface rocks here are underlain by Precambrian formations, but the United States has had no systematic drilling program to examine them.

Our knowledge about later chemical events affecting mineralization is not much better. Most of the ore that has been found in this country was discovered by primitive techniques—you might say, by stumbling over it. Recently, the discovery process has been aided by results from Landsat satellites and by the concept of colliding tectonic plates, but much of the physical chemistry of the mobilization of elements remains a mystery. For example, many ores occur as insoluble sulfides. How were the cations concentrated and brought to their final position? Where did the sulfur come from? If we understood this process and others we could predict much better where and how to explore for ores.

A decade or more elapses from the time of discovery of an ore body to exploitation. If this country is not to become a pawn in an international game of materials, it must begin to develop a more vigorous materials policy.

—PHILIP H. ABELSON