

# Environmental Geochemistry: Health and Disease

AAAS Symposium • 30 December 1968

Dallas, Texas

A growing need for coordinated interdisciplinary research in the interpretation of geographic patterns of disease has prompted the organization of a symposium sponsored by the Geological Society of America, "Environmental Geochemistry in Relation to Human Health and Disease," which will be held on 30 December 1968 at the AAAS Meeting in Dallas, Texas. The symposium will consist of a morning session of papers on environmental geochemistry and an afternoon session on trace metals in human health and disease.

The morbidity and mortality rates of many chronic diseases can be shown to have definite geographic patterns throughout the world. The causes of the patterns are largely unknown, but the possibility that they may be related, in part, to environmental geochemistry needs to be explored. Environmental geochemistry, for the purpose of this symposium, encompasses the chemistry of rocks, soils, plants, and water in their natural states.

For a long time, medical emphasis has been on disease rather than health. Most often health has been thought of as merely freedom from disease. The overt manifestations of severe chemical deficiency or of acute toxicity are easily evaluated and their causes easily discerned. But responsibility should be recognized for searching out those subtle multifactorial causes of sub-optimal health that sap the energy, depress the motivation, and increase the susceptibility to those continual stresses inherent in our environment. These same minor deficiencies or excesses may also, given time, produce diseases that were considered, until several years ago, "inherent." For example, recent evidence suggests: that copper fulfills an essential requirement for connective tissue development and that deficiency may simulate "collagen disease"; that

zinc, in addition to its influence on tissue regeneration (especially wound healing), affects maturation of the whole human organism, and furthermore, that it may have an etiologic role in atherosclerosis; that chromium deficiency has a significant effect on glucose metabolism, an effect that may simulate diabetes mellitus; and that a variety of trace elements act as carcinogens in populations exposed to the everyday hazards of air, water, and food pollution.

The present state of our knowledge in the field of geochemistry concerning the distribution of elements in various rock types of the substrate, the retention or dispersal of these chemical constituents during the process of weathering to soils, their transport in water, and absorption by plants will be explored. For example, the high contents of calcium and magnesium in limestones; the potassium and other metals in shales; the potassium and sodium of silicic igneous rocks; the iron, magnesium, and other metals of basic igneous rocks; and the low contents of many elements in sandstones may influence the chemical composition of groundwater and may also affect the composition of soils and plants. The retention and dispersal of the chemical constituents in soils, and their absorption by plants, depend largely upon the degree of weathering, the age of drainage pattern development, and the climate. Thus geologic materials, together with their dispersed weathering products, create areal patterns that can be recognized as geochemical provinces.

The correlation between geochemical provinces and the elemental contents in the vegetation depends in large part upon the chemical and biochemical behavior of the particular element and the requirements of the plant. Some plants in arid regions accumulate metals such

as molybdenum and selenium that are soluble under alkaline conditions; some plants in humid regions accumulate metals such as zinc that are soluble under acid conditions. Of the elements studied, the absorption of selenium, molybdenum, and lithium by plants correlates most closely with the total amounts of these elements in the soils.

Variations in trace metal contents of potable water, on the other hand, are more closely tied to the geologic source of the metals. The chemistry of the groundwater is directly related to that of the aquifer; the chemistry of surface water is generally related to the rocks and surficial materials of the watershed. Water from a particular municipal system is often collected from several watersheds and may vary considerably in chemical composition, depending upon its source. The establishment of optimum levels for mineral solutes in water, and of tolerance limits for mineral pollutants are important health objectives. These, and the effects of subsequent treatment on the minor element solutes, are of sufficient importance to warrant a comprehensive investigation.

Specific areas of the United States, and other areas throughout the world that are geologically distinctive, are known to be characteristically enriched or deficient in such elements as F, I, Se, Mo, Mn, Cu, Co, B, Ba, Fe, Cr, Zn, P, Mg, or Ca; non-optimal levels of many of these elements in animals and human beings are known to be injurious to health.

Thus the variance from optimum levels of a particular element in plants and water may be predictable from geologic criteria, and an exhaustive and rigorous comparison of geographic disease patterns with geologic and geochemical maps in the search for causal relationships may be an appropriate entry into the problem.

The symposium has been designed to explore these various interrelated geochemical and biomedical factors and to summarize the present state of our knowledge in these fields. Furthermore, we expect that the symposium will help to illuminate those important areas of connection between environmental geochemistry, health, and disease that are most pertinent for interdisciplinary collaborative study.

H. L. CANNON

H. C. HOPPS

*U.S. Geological Survey and Armed  
Forces Institute of Pathology*

## Speakers and Topics

Arrangers: Helen L. Cannon (U.S. Geological Survey, Denver) and Howard C. Hopps (Armed Forces Institute of Pathology)

### 30 December (morning)

#### Geochemical Aspects

Chairman: Helen L. Cannon.

*Geographic Pathology and the Medical Implications of Environmental Geochemistry*, Howard C. Hopps.

*The Chemical Composition of Rock Types as Factors in Our Environment*, Harry A. Tourtelot (U.S. Geological Survey, Denver).

*Regional Geochemical Reconnaissance in Medical Geography*, John S. Webb (Royal School of Mines, London).

*Minor Elements in Water*, Marvin W. Skougstad and Paul R. Barnett (U.S. Geological Survey, Denver).

*Regional Plant Chemistry as a Reflection of Environment*, J. F. Hodg-

son and W. H. Allaway (U.S. Department of Agriculture, Ithaca, N.Y.).

*Panel Discussion, Problems in Assessing Geochemical Environment*, F. Earl Ingerson (University of Texas, Austin) will be discussion leader. Panel members: Harry V. Warren (University of British Columbia), Fred N. Ward (U.S. Geological Survey, Denver), Alfred T. Miesch (U.S. Geological Survey, Denver), and Helen L. Cannon.

### 30 December (afternoon)

#### Human Health and Disease Aspects

Chairman: Howard C. Hopps

*Trace Elements and Human Nutrition*, Arnold E. Schaefer (National Institutes of Health).

*Geographic Patterns in the Risk of Dying*, Herbert I. Sauer and F. R. Brand (U.S. Public Health Service, Columbia, Missouri).

*Medical Geography and Its Geological Substrate*, R. Warwick Armstrong (University of Illinois).

*Trace Elements Related to Specific Chronic Diseases*: (i) *General Considerations*, Fred L. Losee (Eastman Dental Center, Rochester, N.Y.); (ii) *Cardiovascular Disease*, H. Mitchell Perry, Jr. (Veterans Administration Hospital, St. Louis); (iii) *Cancer*, Arthur Furst (Institute of Chemical Biology, University of San Francisco); and (iv) *Other*, Walter Mertz (Walter Reed Army Institute of Research, Washington, D.C.) and Walter J. Pories (University of Rochester).

## Penetration of $\text{CaCO}_3$ Substrates by Lower Plants and Invertebrates

AAAS Symposium • 28–30 December 1968 • Dallas, Texas

Symposium arranged by Melbourne R. Carriker (Marine Biological Laboratory, Woods Hole, Massachusetts), Edmund H. Smith (University of the Pacific, Dillon Beach, California), and Robert T. Wilce (University of Massachusetts)

### 28 December (morning)

#### Substrate Structure and Dissolution by Non-Organic Forces

Introduction, Edmund H. Smith.

*The Comparative Ultrastructure and Organization of the Prismatic Region of Three Bivalves, and Its Possible Relation to the Chemical Mechanism of Boring*, Dorothy F. Travis and Mary Gonsalves (Massachusetts General Hospital).

*Organic Composition of Some Molluscan Shell Structures, Including Periostracum*, P. E. Hare (Geophysical Laboratory, Washington, D.C.) and V. R. Meenakshi (Duke University).

*The Internal Shell Microstructure*

*of Bivalved Mollusks*, Iwao Kobayashi (Niigata University).

*Chemical Solution of Calcium Carbonate in Seawater*, Ricardo M. Pytkowicz (Oregon State University).

*Effects of Organic Matter on Solubilities and Crystal Form of Carbonates*, Yasushi Kitano, Nobuko Kanamori, and Akira Toluyama (Nagoya University).

### 28 December (afternoon)

#### Fossil Penetrants: Penetration by Lower Plants

Chairman, Robert T. Wilce.

*Paleozoic Shell Boring Annelids and Their Trace Fossils*, Barry Cameron (Boston University).

*Paleoecology of Boring Barnacles*, Adolf Seilacher (University of Tuebingen).

*Paleoecology of Bored Lacustrine Shells and Ultra-structural Diagenesis*, Alan P. Covich (Yale University).

*The Fossil Record of Shell Boring*

*by Snails*, Normal F. Sohl (U.S. Geological Survey).

*Distribution, Taxonomy, and Boring Patterns of Marine Endolithic Algae*, Stjepko Golubic (Yale University).

*Endolithic Algae in Calcareous Desert Rocks*, E. Imre Friedmann (Florida State University).

*The Effect of Fucus sp. on Calcareous Substrata*, Harold Barnes and J. Topinka (The Marine Station, Millport, Scotland).

### 29 December (morning)

#### Penetration by Lower Plants: Penetration by Invertebrates

Chairman, Melbourne R. Carriker.

*Interference with Mineral Deposition in a Coccolithophorid Protozoon*, Henry D. Isenberg and Leroy S. Lavine (Long Island Jewish Hospital).

(Program is continued on next page.)

*Role of Marine Fungi in the Penetration of Calcareous Substances*, Jan Kohlmeyer (University of North Carolina).

*Burrowing Marine Invertebrates in Calcareous Terrigenous Rocks of the Pacific Coast*, John E. Warne (Rice University) and Neil F. Marshall (Scripps Institution of Oceanography).

*Observations on the Borers in the Shell of the Bivalve Placopecten magellanicus*, John W. Evans (Memorial University, Newfoundland, Canada).

*The Penetration Mechanism of the Boring Sponge Cliona*, William R. Cobb (University of Rhode Island).

*Parvatremas spp.: Decalcifying Metacercariae in Intertidal Clams*, Steven Obrebski (State University of New York at Stony Brook).

*Systematics and Biogeography of Burrowing Bryozoans*, John D. Soule (University of Southern California).

*A Review of Coral Inhabiting Sipuncula*, Edward B. Cutler (Utica College of Syracuse University).

*Structure of Possible Boring Organs in Sipunculids*, Mary E. Rice (Smithsonian Institution).

#### 29 December (afternoon)

##### Penetration by Invertebrates

*Chairman*, Howard H. Chauncey (Veterans Administration).

*Systematics and Ecology of Shell Boring Polychaetes from New England*, James A. Blake (University of Maine).

*The Boring Mechanisms of Polydora websteri (Annelide, Polychaeta) in Relation to Crassostrea virginica*, Sarah A. Haigler (Virginia Institute of Marine Science).

*Boring of Shell by Caobangia spp. in Freshwater Snails of Southeast*

*Asia*, Meridith L. Jones (Smithsonian Institution).

*Shell Burrowing Barnacles*, Jack T. Tomlinson (San Francisco State College).

*Hormonal Effects on Calcium Metabolism in Crustacea*, M. A. McWhinnie, M. O. Cahoon, Sr., and R. Johannek (De Paul University).

*Some Behavioral Aspects of the Hole Boring by Octopus*, John M. Arnold and Kristin Okerlund Arnold (University of Hawaii and University of Minnesota).

*Drilling and Feeding of Gastropods by Octopus*, Jerome Wodinsky (Brandeis University).

#### 30 December (morning)

##### Penetration by Invertebrates

*Chairman*, Marie U. Nylen (National Institutes of Health).

*Comparative Study of Bivalves Which Bore Mainly by Mechanical Means*, A. I. Ansell (The Marine Station, Millport, Scotland) and N. Balakrishnan Nair (University of Kerala, India).

*Chemical Destruction of Limestone by Three Mytilid Clams*, Norman M. Hodgkin (University of Oklahoma).

*Fungiacava eilatensis n. gen., n. sp. (Bivalvia, Mytilidae), A Boring Bivalve Commensal in Reef Corals*, T. F. Goreau and N. I. Goreau (University of West Indies, Jamaica, and State University of New York, Stony Brook), T. Soot Ryen (Zoologisk Museum, Oslo, Norway), and C. M. Yonge (University of Glasgow, Scotland).

*Functional Morphology of Penitella conradi relative to Shell Penetration*, Edmund H. Smith.

*Decalcification at the Mantle-Shell Interfact in Mollusks*, Miles A. Cren-

shaw and Jerry M. Neff (University of North Carolina).

*Ecological Aspects of Some Coral Boring Gastropods and Bivalves of the North Western Red Sea*, Gamil N. Soliman (University of Cairo).

*Beach Rock Destruction by Marine Gastropods at Boca Raton, Florida*, Alan K. Craig (Florida Atlantic University).

*Okadaia elegans, a Boring Nudibranch from the Indo-West-Pacific*, David K. Young (Boston University).

#### 30 December (afternoon)

##### Penetration by Invertebrates

*The Proboscis and Proboscis Gland of the Cymatiid mesogastropod Argobuccinum argus*, Jennifer A. Day (University of Cape Town).

*Study of Bore Holes of the Gastropod Urosalpinx by Means of Light and Scanning Electron Microscopy*, Melbourne R. Carriker and Dirk Van Zandt (Marine Biological Laboratory, Woods Hole).

*Fine Structure of the Accessory Boring Organ of the Gastropod Urosalpinx*, Marie U. Nylen, V. Provenza (University of Maryland), and Melbourne R. Carriker.

*Carbonic Anhydrase and Decalcification by the Accessory Boring Organ of the Shell Penetrating Gastropod Urosalpinx*, Howard H. Chauncey, Anne Smarsh (Veterans Administration Hospital, Boston, and Marine Biological Laboratory, Woods Hole) and Melbourne R. Carriker, and Philip Person (Veterans Administration Hospital, Brooklyn, New York).

*Carbonic Anhydrase and the Shell Boring Mechanism of the Gastropod Purpura (Thais) lapillus*, M. Chetail and A. M. Rosenberg (Université de Paris).

*General Program Notes on the AAAS Annual Meeting (26-31 December 1968) appear in the 4 October issue of Science. Hotel reservation forms and meeting and tour registration forms appear in this issue of Science and will appear in alternating issues. Reports of symposia at the Meeting appear in the following issues: 13 September, "Sport and Its Participants"; 20 September, "The Control of Fertility"; 27 September, "Unanticipated Environmental Hazards"; 11 October, "Continuing Education for Engineers"; 18 October, "Antarctic Research"; 25 October, "Water Importation into Arid Lands"; 1 November, "Jupiter and the Outer Planets"; and 8 November, "Use of Space by Animals and Men."*