

Meetings

Amorphous Clay Materials

Amorphous clay materials, specifically allophanes, which are hydrous aluminum silicates in the colloidal size range, primarily occur in association with volcanic ashes and in soils of volcanic origin. They are commonly formed during the earlier stages of the weathering process, and with continued weathering they may be transformed into crystallized clay minerals. Since in volcanic regions the time scale of deposition of ashes and their weathering can often be assessed with reasonable accuracy and since climatic conditions are well known, exceptional possibilities are offered for the study of weathering processes, soil formation, and natural diagenesis of silicates.

When present in soils, even relatively small amounts of these amorphous clay materials have a marked effect on soil properties and soil productivity as a result of their large surface area and high chemical reactivity, which poses a number of problems in practical soil management.

The amorphous clay materials are abundant both in Japan and in the Pacific Northwest of the United States and Hawaii. They have been studied widely in both countries, and, although considerable progress has been made, many problems remain to be solved. Hence, the time seemed ripe to take stock and to plan future research by organizing a seminar under the auspices of the United States-Japan Cooperative Science Program. Such a seminar was held in Fukuoka, Japan, 17-19 September 1969. In addition to the members of the delegations from Japan and the United States [coordinators were S. Aomine (Kyushu University) and H. van Olphen], scientists from four other countries (Australia, Germany, Israel, and U.S.S.R.) participated. The following technical notes and conclusions will be of general interest.

Definitions and Nomenclature

Historically, the term "allophanes" has been used to designate naturally

occurring amorphous hydrous aluminum silicates of widely varying chemical composition. In general, a mineral is defined by its chemical composition, its structural characteristics, and its morphological features. Obviously, the range of chemical compositions of allophanes is too large to permit one to designate allophane as *one* mineral, and it may well be that we are dealing with a mineral series. If so, it must be shown that their properties change recognizably and continuously with chemical composition, and the end members of the series must be defined. (Alumina and silica would not be the end members of such a series since allophanes are aluminum silicates containing Al-O-Si bonds.)

From the mineralogist's point of view there is no fixed boundary between crystalline and noncrystalline ("amorphous") substances. The term "amorphous" is vague since it relates to the technique used to determine structure, and the term "of short range order" must be preferred, although it is not possible at present to define exactly how short "short range order" would be in this case.

The following tentative definition was proposed: "Allophanes are members of a series of naturally occurring minerals which are hydrous aluminum silicates of widely varying chemical composition, characterized by short range order, by the presence of Si-O-Al bonds, and by a differential thermal analysis curve displaying a low temperature endotherm and a high temperature exotherm with no intermediate endotherm."

Characterization

The method of selective dissolution was recommended for the analysis of naturally occurring mixtures of allophanes and other minerals, but the high reactivity of the allophanes calls for special caution. Awareness of the possible presence of eolian aerosol material is important, and isotopic analysis techniques should be applied for their detection. Among modern tech-

niques, neutron activation analysis and microprobe analysis were favored.

It was recognized that the characterization of the surface of allophane particles would not only be important by itself but would also supply clues for the analysis of the bulk structure. Functional groups on the surface, their physical and chemical reactivity, and their distribution should be determined for both dry and hydrous systems.

For dry systems the determination of acidity (by the use of indicators), and of siloxane and silanol groups will be important for the characterization of functional groups, whereas vapor-phase adsorption isotherms and determinations of heats of wetting will supply information on surface energies as well as surface area.

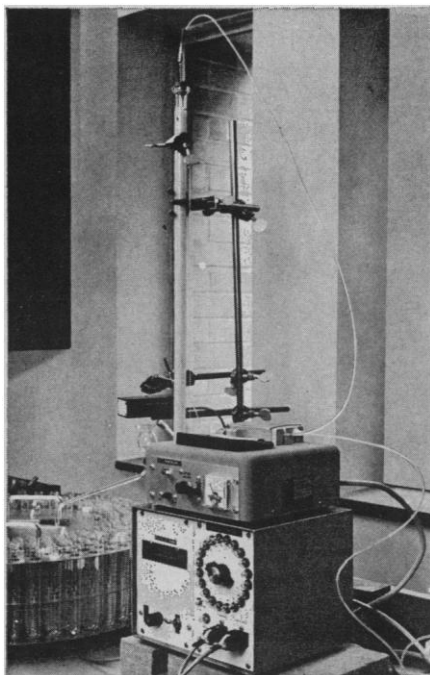
For hydrous systems the electrical double layer parameters should be determined. These include ion exchange parameters (cation and anion exchange capacity, exchange hysteresis, ion selectivity); adsorption of potential-determining ions and point of zero charge; electrokinetic properties; and colloidal stability as an indirect measure of double layer properties. It was emphasized that ion exchange capacity is not a material constant for minerals such as allophanes which are likely to have surfaces characterized by broken bonds. The exchange capacity will depend on the composition of the equilibrium liquid since the surface potential will be determined by the pH of the equilibrium liquid, and at each pH value the surface charge will increase with the increasing concentration of an indifferent electrolyte.

For the physical characterization of the amorphous materials those techniques should be emphasized that are particularly pertinent for the study of such materials, that is, x-ray fluorescence, various spectroscopic techniques, and electron microscopy. By means of the latter technique the presence of gel-like hulls around the particles occurring at certain stages of weathering was revealed. It was also recently established by high-magnification electron microscopy that imogolite fibers have a tubular morphology.

Occurrence, Genesis, Synthesis

Descriptive work on the occurrence of amorphous clay materials should include the gathering of geological information and data on the age of deposit and environmental conditions from the time of deposition to the present. It was considered desirable

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that deposits of potential economic value be earmarked as such.

In the study of the mechanism and course of genetic and diagenetic changes, it was recommended that model reactions be studied in the laboratory; the investigator should start with pure, well-defined, simple systems and gradually increase the complexity of the system by adding more components. It was stressed that more laboratory work will be needed on synthesis at low temperatures and pressures.

Soils

The presence of amorphous materials in soils creates several problems. Because of the high reactivity of these materials and their large specific surface area, the chemisorption of inorganic fertilizers often makes large fractions of the added fertilizers unavailable to the plants. Furthermore, the adsorption of pollutants from streams and from the atmosphere often causes considerable soil pollution. The large and strong adsorption capacity of the amorphous materials may well upset biological activity and balance in soils. It was emphasized that much fundamental and applied work would be needed in these highly important areas.

The permeability of volcanic soils is often high, thus causing excessive drainage which poses problems in rice growing. Measures to remedy this situation, such as the addition of bentonites, require more study of the factors governing colloidal stability to which the problem is directly related.

The colloidal properties of soils are also directly related to properties such as strength, swelling, and shrinking, which are of importance for foundation engineering and road building.

Industrial Applications

Industrially, the use of the amorphous materials should be explored for those applications where small particle size and high adsorption capacity and large surface area are important. On the basis of knowledge of the structure and chemistry of the surface, it will be possible to chemically modify the surface to tailor the colloidal system to suit a particular application. Potential fields of application are in ceramics, paints, fillers, drilling fluids, lubricating greases, defoaming, ion exchange, heterogeneous catalysis, and adsorbents.

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Forthcoming Events

February

9–11. **Aerospace and Electronic Systems**, 12th annual winter conv., Los Angeles, Calif. (W. H. Herrman, Inst. of Electrical and Electronics Engineers, Inc., Los Angeles Council Office, 3600 Wilshire Blvd., Los Angeles 90005)

9–11. **Advanced Planning for Industry on Ships and Marine Systems**, Washington, D.C. (National Security Industrial Assoc., Dept. NM, Suite 700, Union Trust Bldg., 15th and H Sts., NW, Washington, D.C. 20005)

9–11. **Weed Science Soc. of America**, Dallas, Tex. (D. L. Klingman, Agricultural Research Service, U.S. Dept. of Agriculture, Beltsville, Md. 20705)

9–12. **Conference of the Reinforced Plastics/Composites Div.**, 26th, Washington, D.C. (C. Condit, Soc. of the Plastics Industry, Inc., 250 Park Ave., New York 10017)

10–11. **Vinyl Plastics II—Fundamentals of Processing Techniques**, Atlanta, Ga. (J. Seay, School of Architecture, Georgia Inst. of Technology, 225 North Ave., NW, Atlanta 30332)

11–13. **Society of University Surgeons**, New Haven, Conn. (T. Drapanas, Tulane Univ., New Orleans, La. 70112)

12. **Society of Teachers of Family Medicine**, Chicago, Ill. (Miss G. Gillespie, Div. of Family Medicine, Box 875, Biscayne Ave., Miami, Fla. 33152)

14–15. **American Medical Assoc., Medical Education**, 67th annual congr., Chicago, Ill. (C. H. W. Ruhe, AMA Council on Medical Education, 535 N. Dearborn St., Chicago 60610)

14–18. **American Soc. of Abdominal Surgeons**, New Orleans, La. (B. F. Alfano, ASAS, 675 Main St., Melrose, Mass. 02176)

14–18. **American Soc. of Range Management**, 24th annual, Reno, Nev. (F. T. Colbert, ASRM, 2120 S. Birch St., Denver, Colo. 80222)

15–16. **Virus and Water Quality: Occurrence and Control**, 13th annual, Urbana, Ill. (V. L. Snoeyink, Dept. of Civil Engineering, Univ. of Illinois, Urbana 61801)

17–18. **Conference on Integrated Information Systems**, Palo Alto, Calif. (R. W. Rector, Cognitive Systems, 319 S. Robertson Blvd., Beverly Hills, Calif. 90211)

17–19. **Solid State Circuits**, intern. conf., Philadelphia, Pa. (R. W. Webster, Texas Instruments, P.O. Box 5012, Dallas, Tex. 75222)

17–24. **Therapeutic Use of Dreams**, New York, N.Y. (H. Gersham, American Inst. for Psychoanalysis, 329 E. 62 St., New York 10021)

18–19. **Theoretical Chemistry and Sulfur Chemistry**, 3rd annual symp., New Orleans, La. (L. P. Gary, Jr., Loyola Univ., New Orleans 70118)

18–20. **Experimental Nuclear Magnetic Resonance**, 12th annual conf., Gainesville, Fla. (J. M. Anderson, Bryn Mawr College, Bryn Mawr, Pa. 19010)

18–21. **Western Electroencephalography Soc.**, Honolulu, Hawaii. (D. Crowell, Pacific Biochemical Research Center, Univ. of Hawaii, Honolulu 96822)