

# EES NOTES

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## IDD'S BRANCH OFFICE SYSTEM

To localize and personalize all of its industrial and economic development services throughout Georgia, the Industrial Development Division in 1961 pioneered an extension program that has grown into a statewide network of seven branch offices. Field services began with an office in Rome to provide, under contract, an economic development program for the newly formed 12-county Coosa Valley Area Planning and Development Commission, the first group of its kind in the state. The success of this branch office approach was such that by 1967, professional staffs were in residence at Albany, Augusta, Carrollton, Douglas, Macon, Rome, and Savannah.

While the purpose of all branch offices is essentially the same -- to provide technical support to local development efforts -- the work of each is directed toward the specific needs of the multi-county area it serves. In some instances, the branch office performs, under contract, the industrial development effort for a sponsoring agency throughout its service area, while also assisting in the implementation of such state-federal sponsored programs as the Economic Development Administration's (EDA) technical assistance program and the Georgia State Technical Services (GSTS) program which provides technical information transfer to industry. In others, the branch office may perform industrial development services, under contract, within a portion of its service area, while also assisting in the implementation of other programs throughout the total area. In two instances, branch offices have been established principally to assist in the conduct of the EDA and GSTS programs, with a lesser degree of activity in the field of industrial development. The principal difference among branch office operations is in emphasis.

Activities of IDD's branch offices generally fall into three broad categories: technical assistance to local development organizations, aid to area or multi-county development groups, and assistance to existing industry.

Technical assistance to local (community or county) groups involves industrial development program guidance and, in cases where no suitable organization such as a chamber of commerce or development authority exists, assistance in creating a viable organization. Another basic task of the branch office staff is the collection and analysis of industrial resource data to determine the potential of the individual communities for industrial development. This task includes the compilation and publication of community resource audits and specialized studies on such topics as existing industry, raw materials, labor availability and skills, wage rates, and utility and transportation services. Through economic research, opportunities for new manufacturing industries, as well as for expansion or diversification of

established ones, also are identified. Industrial site identification is another important branch office function, as is assistance to local groups in providing industrial prospects that information required to make a plant location decision on an economically sound basis.

Similar types of technical assistance are offered to area development groups. However, branch office staff members also are available to assist area planning and development commission planners with land-use studies, traffic and thoroughfare studies, proposals for federal grants and loans, and other related activities.

Technical assistance to existing industry in the branch office service area generally involves systems improvements, expansions, or diversifications. Under systems improvements fall such matters as materials handling, manufacturing process flow, markets and distribution, personnel policies and training, sources of raw materials, and organizational or management structure. Assistance in plant expansion may include the location of necessary capital, the determination of an adequate labor supply, plant layout guidance, location of additional sources of raw materials, and market and distribution studies. IDD also helps local manufacturers in diversifying their product lines through the conduct of market studies, which may indicate product lines compatible with their existing processes and their probable market success, and the identification of company acquisition possibilities.

By placing industrial developers and engineering specialists in residence at strategic locations over the state, the Industrial Development Division offers to community and area development groups technical capabilities that otherwise would not be available on these levels. In turn, the effectiveness of IDD's industrial development efforts is enhanced by the attainment of firsthand knowledge of the problems and potentials of the areas served by the respective branch offices. In addition, the public relations value of having Georgia Tech representatives living in the areas outside Atlanta is considerable. These men provide a valuable liaison between the communities of the state and the Georgia Tech campus. Not only does IDD call on the technical support of other divisions of EES and the academic departments from time to time, but branch office personnel also are available to perform field work or other services for projects directed by non-IDD faculty members. Thus, this unique "industrial extension service" provides benefits to both the state at large and to the Institute itself.

David C. Morgan  
Industrial Development Division

## HF RADIOLOCATION AND PROPAGATION EXPERIMENTS DURING THE MARCH 7 SOLAR ECLIPSE

At frequencies below about 30 MHz, long-range radio communications are propagated via alternate refractions in the ionosphere and reflections from the earth's surface. In this manner, communications can be obtained over distances to several thousand kilometers.

Since the ionosphere is dependent on sunlight as its principal ionization source, any removal of that source creates significant variations in signal propagation characteristics. A solar eclipse is useful to the ionospheric researcher because it produces a very rapid, but short-lived, decrease in ionospheric ionization level.

The March 7 solar eclipse provided an excellent opportunity for studying eclipse-induced effects on high-frequency (HF) propagation and radiolocation characteristics. Radiolocation characteristics are of interest because variations in the direction of arrival of the signal afford a study of ionospheric parameters such as layer tilting and traveling disturbances. The shadow track passed through a region of the world containing numerous HF transmitting stations, thereby permitting the choice of a wide variety of transmission frequencies and ionospheric paths. Ionization is highest near noon during the winter at a peak of the 11-year sunspot cycle; the March 7 eclipse occurred under these conditions. Therefore, it was possible to study eclipse effects on a "hard," relatively stable ionosphere at a time when the ionosphere is most resistant to change.

The radiolocation experiments by the Electronics Division during the March 7 eclipse involved measuring the bearing accuracy and dispersion of selected test transmissions using a direction-finding system developed by the Communications Branch. This system, which is located at Georgia Tech's DeKalb County direction-finding (DF) site some 14 miles east of the campus, operates as an interferometer and determines signal direction of arrival by phase comparison between spaced dual antenna arrays. In addition to the interferometer array, the system includes a special-purpose DF receiver, signal processor, bearing display, and readout equipment.

The objectives of the propagation experiments, which were performed on-campus, were (1) to determine eclipse-induced effects on signal amplitude and fade characteristics and (2) to observe the overall effects on the upper HF region (10-20 MHz) by means of broadband spectral analysis.

Transmissions from four radio stations in Mexico, Cuba, Canada, and the U. S. were used in these tests. Their locations afforded propagation paths both longitudinal and transverse to the shadow track. The longitudinal paths were used to study eclipse-induced effects, such as traveling disturbances, on transmission paths

not directly affected by the shadow track. The transverse paths were of major interest since the shadow track eclipsed portions of the ionosphere along the direct transmission path. The operating frequencies of the test transmissions were in the 15 MHz region, which is slightly below the predicted maximum usable frequency (MUF). This region would be more sensitive to ionospheric changes than would lower frequencies.

Radiolocation and propagation data obtained during the eclipse were compared with reference data obtained on control days before and after the eclipse and on March 7 prior to the onset of the eclipse. These data enabled eclipse-induced effects to be separated from normal variations.

Radiolocation test results show that bearing accuracy and dispersion were not significantly affected by the eclipse. In fact, bearing dispersions were slightly reduced during the eclipse interval.

Propagation characteristics of all the test transmissions were significantly different during the eclipse period. Signal strengths tended to increase slightly; fade rates were much higher and time-correlated with the shadow location. (The received signal strength varies or fades as a function of time, and the number of fades/sec is called the fade rate.) At times, fade rates increased by an order of magnitude and significantly degraded transmission intelligibility. The highly disturbed conditions were of several minutes' duration; however, the eclipse-induced abnormalities persisted for periods approaching one hour.

Broadband spectral analysis disclosed that signal levels in the entire 10-20 MHz region were slightly enhanced during the eclipse, but that no portion of the observed spectrum suffered a "blackout" condition, i.e., a severe loss of signal.

It should be noted that the observed variations from normal conditions could have been caused by factors completely independent of the eclipse. For example, the numerous rocket probes launched March 6, 7, and 8 for ionospheric sampling could have altered propagation characteristics. Similarly, the enhanced HF spectrum could have been created by the presence of HF transmissions active only during the eclipse interval for test purposes.

A report on these observations has been submitted to the U. S. Solar Eclipse Coordinating Group for inclusion in the 1970 Solar Eclipse Bulletin which is being prepared by the National Science Foundation.

H. H. Jenkins  
Electronics Division

## ATTAPULGITE AND MONTMORILLONITE SEPARATION

The clay mineral attapulgite derives its name from the city of Attapulcus, Georgia, where it was first discovered. Microscopic examination shows that it is made up of elongated fibers which may be in bundles, producing a woven textured appearance similar to that of paper. This clay mineral has a wide usage in the ceramic, chemical, and petroleum industries. Although it has a high iron content which affects product color, it has excellent plastic properties and, therefore, is used in the manufacture of porcelain and earthenware. Attapulgite also has moisture absorbent properties which make it desirable for use in the clarification of oils, as a carrier for insecticides, a soil conditioning agent, a viscosity builder, and an emulsion stabilizer.

Montmorillonite also is a clay-like mineral which derives its name from the locale where it was discovered, Montmorillon, Department Vienne, France. It occurs in platelets and adsorbs water whenever it is available. Water adsorption occurs on the basal surfaces of the clay and in this fashion pries adjacent flakes apart, resulting in an overall volume increase of the clay and thus an increase in the viscosity of the suspending fluid. Montmorillonite, when present in the amount of only 1% to 2%, causes even a coarse-grained material to become plastic. This property makes it attractive for use in the ceramic industry as a binding, suspending, and plasticizing agent. Like attapulgite, it is used in the chemical and petroleum industries.

Both attapulgite and montmorillonite are used as drilling muds. Montmorillonite, however, can be used only if the electrolyte content of the area in which the drilling occurs is low because of its characteristic flocculation in concentrated electrolytic fluids, such as sea water. In contrast, attapulgite is highly stable in saline suspensions, that is, it does not flocculate in electrolytes; instead, it becomes colloidal in nature. This feature makes this material very attractive for drilling mud use. However, almost all attapulgite clays contain some montmorillonite as an impurity. This impurity, even in small quantities, affects the rheological properties (viscosity) of attapulgite in a saline suspension. This impurity problem led to an undergraduate project by the author which was directed toward developing an efficient means of removing montmorillonite from attapulgite.

Attapulgite and montmorillonite have almost identical physical characteristics in terms of color, density, and apparent texture. The chemical composition, particle size and shape, and behavior in electrolyte suspensions are the major properties which differ; thus, these properties are employed in the separation of these clays by centrifugation. When an attapulgite clay which is contaminated by

montmorillonite is suspended in a concentrated electrolyte, the attapulgite fibers will become colloidal and disperse, whereas the montmorillonite platelets will flocculate and settle out.

The undergraduate project work indicated that the feasibility of purification of attapulgite by separation with centrifugal sedimentation was possible, especially with repeated dispersals and sedimentations of the sample. However, project time limit did not permit determining the extent of purification that could be obtained with this technique. (Editor's Note: The author has now joined the staff of HTMD, and it is planned that research on purification will be continued as time and funds become available.)

Kathryn V. Logan  
High Temperature Materials Division

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#### PRECISION CRYSTALLOGRAPHY AND THE APATITE PROJECT

Often referred to as "the tooth project," this study encompasses broad interests sharing a common concern with understanding of atomic-scale mechanisms from both crystal physics and dental research viewpoints. The dental research aspect is particularly oriented toward problems in tooth decay.

Understanding of the mechanism of a phenomenon is, of course, concomitant to its deliberate control. If one knew the precise location and thermal vibration of each atom in a material, he would, in principle, be able to establish atomic-scale mechanisms of physical properties and functions. The deduction of such mechanisms is promised by the continued development and application of precision structure refinement techniques utilizing data obtained by the diffraction of X-rays, neutrons, and electrons. Parameters of interest include not only temperature, pressure, electric and magnetic field strength, etc., but also impurity and defect concentrations.

To give an idea of the significance of these problems, in the biological area alone, examples of mechanisms of function would include the mechanism of muscle function, the mechanism by which the hemoglobin molecule carries oxygen to the cell and carbon dioxide away, and the physical and molecular basis of the mechanism of memory.

Determination of the structural location of impurities and their role in material properties is a consistent thread that runs throughout the present "tooth project" work. Hydroxyapatite,  $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$ , the principal inorganic constituent of bones and teeth, may be taken as a prototype of the apatites. The kind and amount of substitution within the apatite structure frequently can be selected to fit the experimenters' choice. Thus, the apatites constitute an accommodating series of specimens for these studies.

The specimens used come from several sources -- mineral, synthetic, and biological. Synthetic specimens are prepared here in both powder and single-crystal form. Emory University dental students make a particular contribution to the project in collection and preparation of human dental enamel -- one neutron diffraction specimen requires the harvest from about 150 teeth.

The principal tools used are the X-ray and neutron diffraction techniques. Single-crystal studies permit determination of a variety of plausible models for natural materials which are available only in polycrystalline form (ordinarily impure). The plausible models are then used as a basis for calculations of the polycrystalline (powder) diffraction pattern that would be expected if the natural material in question were well represented by the model being used.

Some Results. Since the apatite project has now been in existence for a number of years, a fairly long list of detailed results might be recited. Generally, the results obtained have mineralogical and biological, as well as crystal-physical, implications.

In a biological sense, the most significant results obtained to date are (1) the determination that there is a deficiency of structural hydrogen in the hydroxyapatite portion of human dental enamel and (2) the recognition of a mechanism for fluorine inhibition of diffusion in hydroxyapatite.

Of multidisciplinary interest is the finding that fluorine present in mineral hydroxyapatite at the concentration levels found in the outer layers of dental enamel (approximately 0.3% by weight) is (1) dispersed on the normal fluorine sites of fluorapatite and (2) hydrogen-bonded to the neighboring hydroxyl oxygens to form a three-ion group significantly more strongly bound to its site than is OH alone. Precision structure refinement techniques laid the necessary ground work; the final data needed were provided by nuclear magnetic resonance experiments carried out by a colleague, W. van der Lugt, in The Netherlands.

Among the many other results which have been obtained are the following: (1) the determination of the detailed structures of hydroxyapatite, fluorapatite, and chlorapatite and some of their twinning mechanisms; (2) some insight into the atomic-scale mechanisms of a number of physical properties and differences in chemical stability among three apatites; (3) the location, by direct structural refinement, of an impurity present to the extent of 0.3% by weight (F in hydroxyapatite); (4) the first (preliminary) direct evidence for the location of  $\text{CO}_3$  in carbonate-containing fluorapatite, francolite; and (5) the successful conversion of single crystals of chlorapatite to single crystals of hydroxyapatite.

R. A. Young  
Physical Sciences Division



## RETROFLECTANCE PHOTOMETRIC RANGE

For those who drive, fly, or walk, indeed for almost any mode of transportation, retroreflective devices are important aids to comfort and safety. A reflex reflector is defined as an optical device having the ability to accept light from a near or distance source and reflect this light back to the source in a narrow beam, regardless of the angle at which the light becomes incident upon the reflector. Thus, the device appears bright and self-luminous because of the intensity of the retroreflection.

A variety of retroreflectors are currently available. The painted traffic stripe on roads is clearly visible at night only because the surface is covered with glass microspheres. The glass spheres are a type of retroreflector -- they gather incident light at any angle and return it to the source. A limitation of the retroreflecting paint line is that it is bright only when dry, disappearing when wet. The "quenching" effect of rain has been partially overcome by the use of retroreflecting buttons. These small delineators, usually about 4 by 4 inches in size, have one or more retroreflecting surfaces. Their surfaces are raised above the film of rainwater on the road and inclined so that water runs off.

Examination and evaluation of these devices and of complete roadway delineation systems have become a significant capability of the Chemical Sciences and Materials Division. These systems are monitored by mobile retroreflectance telephotometers which were built to secure continuous data at 40 mph at night and to record the retroreflective brightness levels on magnetic tape for subsequent data processing.

A laboratory photometric range was designed and constructed for calibration of the field telephotometers and for comprehensive characterization of all types of retroreflective units. A 50-foot range was folded in length to 25 feet by use of a front surface mirror. In addition to shortening the range, this brought the target and light source units both alongside a control console convenient to the operator. The target and light source units were automated with servo drives to actuate angular positioning of target and photometer and thus to facilitate the recording of data. Retroreflecting specimens may be highway delineation buttons, 3-foot sections of paint, hot melt plastic, or other continuous media. A means of applying a "rain-fall" also was provided.

The photometric data are presented as "specific intensity" (candlepower reflected per incident foot candle) versus: (1) programmed angles of incidence (azimuth and elevation) or (2) programmed divergence angles (angle formed by the source light beam and the beam reflected to the light sensor or viewer). The data are recorded on X-Y plotters and later may be reduced to iso-illuminance curves on azimuth-elevation coordinates.

In summary, the photometric range provides a capability of characterizing retro-reflectors comprehensively with respect to the angular distribution of reflected light or, if desired, the light emission of sources.

David R. Hurst  
Chemical Sciences and Materials Division

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#### APPLICATION OF SOLID-STATE NUCLEAR TRACK DETECTORS TO BIOLOGIC RADIOAUTOGRAPHY

Ionizing radiations (X-rays, gamma rays from cobalt, and emissions from certain radioactive chemicals) have a lethal effect upon the cells of some cancers. When such radiations are used for cancer treatment, normal tissues adjacent to the cancer also are exposed. Fortunately, normal tissues are less sensitive to irradiation. Nevertheless, some damage is produced in them, causing undesirable complications.

An alternative approach to the radiation treatment of cancer is "neutron capture therapy," which involves concentrating a stable boron compound in the cancer and then exposing the subject to a flux of slow neutrons from a source such as the Georgia Tech Research Reactor. When a boron atom captures a slow neutron it becomes transiently radioactive, emitting an alpha particle and decaying to stable lithium. The alpha particles, traveling a short path through tissue, produce intense ionization which is lethal to the cells through which they pass.

In experiments at Georgia Tech, boron compounds have been administered to mice with cancer, and attempts have been made to determine the location of the boron in normal and cancerous tissue by a method known as radioautography. At different intervals of time after administration of the boron compounds, mice were sacrificed and microscopically thin (0.006 mm) sections of tissue were prepared and, in the darkroom, affixed to a thin film of nuclear track (photographic) emulsion on the surface of a microscope slide. The slides were placed in a light-tight box and exposed to slow neutrons from the nuclear reactor. After development of the emulsion in the darkroom, the tissue was stained for microscopic examination. Under the microscope, the tissue and, adjacent to it, alpha particle tracks in the emulsion were seen. The point of origin of the tracks indicated the location in the tissue of the boron which had undergone alpha disintegration.

This technique was not entirely satisfactory because of background fogging of the emulsion, produced by induced radioactivity of elements other than boron and by the gamma ray content of the reactor beam. This problem has been solved by substituting for the photographic emulsion a solid-state track detector consisting of a sheet of cellulose diacetate. This material is sensitive only to alpha particles under these conditions. When alpha particles are released from boron in tissue, they impinge upon the cellulose diacetate adjacent to the tissue. While producing

no visible effect, they change the chemical reactivity of this material so that the microscopic pits made by the alphas can be etched in its surface by strong alkali and thereby rendered visible. While technical details still need to be refined, this technique offers an alternative to conventional radioautography which may prove superior in other applications.

Allen B. Eschenbrenner  
Nuclear and Biological Sciences Division

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#### BECHTOLD JOINS ELECTRONICS DIVISION STAFF

George Bechtold recently joined the Electronics Division staff as a Senior Research Engineer. His initial assignment has been to the Communications Branch, where he will contribute to several current programs in the area of electromagnetic compatibility and interference analysis. He also will be involved in extending the activities of the branch in the general area of applied electromagnetics.

Dr. Bechtold is a graduate of Duke University, receiving the B.S. degree in 1946 and the B.S.E.E. in 1948. Continuing his academic pursuits on a part-time basis while employed in industry as an electronics research engineer, he received the M.S.E.E. from the University of Pittsburgh in 1953 and the Ph.D. from the University of Pennsylvania in 1967.

Dr. Bechtold's previous work in electronics research involved activities in the areas of ultrasonics, analog computers, flight simulators, control systems, tracking radars, digital checkout systems, magnetic video recorders, and solid-state masers. He comes to Georgia Tech from the Martin Marietta Corporation, which he joined in 1965 as a Senior Research Scientist to direct research in the area of gas interactions at millimeter wavelengths. He performed further investigations in the extension of frequency standards to submillimeter and optical wavelengths. His most recent research, as a Senior Group Leader at Martin Marietta, was concerned with the study and analysis of transient electromagnetic pulse (EMP) effects on electronic systems.

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#### PROFESSIONAL ACTIVITIES

##### Papers and Speeches

James G. Belch, IDD, spoke to the Rome Chapter, Bank Administration Institute, on April 21 on "Economic Outlook for the Coosa Valley Area."

Three CSMD members participated in a Georgia-Florida joint meeting of five local sections of the American Institute of Chemical Engineers held in Daytona Beach, Florida, on May 30. Fred Bellinger presented a paper entitled "Danger! Chemical Disasters!" and Edward Y. Keng read a paper on "Coagulation Behavior of

Typical Industrial Aerosols." John H. Burson chaired a session on "Recent Advances in Chemical Engineering."

On April 29, Robert B. Cassell, IDD, spoke at the Florida Industrial Developers Council meeting in Orlando, Florida, on "Education for Industrial Development."

J. R. Williams, NBSD, presented a paper entitled "Radiant Heat Absorption Parameters of Particle-Seeded Gases" at the Sixth Annual Southeastern Seminar on Thermal Science held in Raleigh, North Carolina, on April 13.

#### Honors and Awards

Robert B. Cassell, IDD, was elected first vice-president of the American Industrial Development Council at its Annual Conference in Kansas City, Missouri, May 10-12.

G. G. Eichholz, NBSD, has been elected president of the Georgia Tech chapter of Sigma Xi for 1970-71. W. H. Burrows, CSMD, and J. D. Clement, NBSD, have been named to the admissions committee.

Kathryn Vance Logan, HTMD, received a Monie A. Ferst Memorial Award for excellence in undergraduate research at the annual awards dinner of the Georgia Tech chapter of Sigma Xi on May 26. Her prize-winning thesis was entitled "Centrifugal Separation of Attapulgitite and Montmorillonite." She received the Bachelor of Ceramic Engineering degree from Georgia Tech in June 1969.

Newly elected president of the Augusta Chapter, American Institute of Industrial Engineers, is L. T. Murphy, Jr., IDD.

#### SUBMISSION OF ARTICLES

Contributors in the divisions should submit their articles to the appropriate division coordinator listed below. Others may send their contributions via campus mail to Martha Ann Deadmore at the Industrial Development Division.

#### Division Coordinators

Chemical Sciences and Materials Division	Walter H. Burrows
Electronics Division	H. A. Corriher, Jr.
High Temperature Materials Division	Nick E. Poulos
Industrial Development Division	Martha Ann Deadmore
Nuclear and Biological Sciences Division	Geoffrey G. Eichholz
Physical Sciences Division	Robert L. Bullock
Rich Electronic Computer Center	John P. McGovern