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One New Strategic Mineral

By EDWARD STEIDLE

THERE ARE ABOUT 1400 natural minerals, some 300 of which are now of commercial value. It falls upon the mysterious quartz crystal to be the only new strategic mineral in World War II. Radio communication, radar, many sound-detecting and locating devices, and range finders developed since World War I, depend on high-quality, clear quartz crystals. Brazil is almost the sole source of crystals of this character. Several hundred tons have been shipped by air into this country since the beginning of Lend-Lease. Our stock pile has caught up with the demand.

Quartz, whether beach sand, sand deposits in our neighboring Barrens, midget crystals in the vicinity of Mt. Nittany, or high-quality crystals in Brazil, is crystalline silicon-dioxide, harder than glass, and the most common of all solid minerals. But there is a catch; crystals for technical use must be untwinned and of suitable purity and size.

Open pit bench mining of quartz crystals in Brazil. (Courtesy of the Diamond Drill and Carbon Company).

A high-quality clear quartz crystal. (Courtesy of the August E. Miller Laboratories).

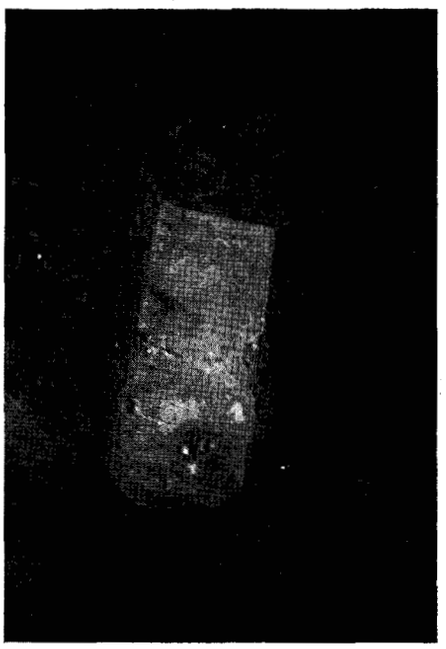
Nature forms quartz crystals in beautifully terminated hexagonal prisms. There are right- and left-handed crystals, and while they may be alike in size, width of faces, and every other respect, it is impossible to bring the two into coincident position. Strangely, too, quartz shows no cleavage, and scratchlike striations run horizontally across the surfaces of the prism faces. Quartz crystals range in size from almost microscopic slivers, often clustered together, to mammoth crystals. The largest single crystal on exhibition in the Mineral Industries Building is 7 inches in diameter, 18 inches long, and weighs 28 pounds. A crystal on display in Bela Horizonte, Brazil, weighs 5 tons.

Quartz may be any color of the rainbow, such as amethyst, rose, and smoky. Sometimes a drop of water or a bubble of gas is found locked in a crystal for eternity. Regardless of size or color, quartz crystals are as distinctive of the mineral as are finger prints of every individual human being. Crystals are the only things shaped perfectly by nature, regardless of their composition, color, size, or strangeness.

In ancient Greece, the quartz crystal won its name, Krustallos, meaning ice. The ancient Greeks thought that in the rarefied atmosphere of mountain peaks the cold was so intense that ice, once frozen at these high altitudes, would never melt and would thus become quartz. Mystical charms were cut from crystals as early as 5000 B.C. Ancients used quartz for burning-glasses for kindling fires and cauterizing wounds. The early art of carving and engraving by the Sumerians was mastered by the Egyptians as early as 2000 B.C., and objects of rare beauty were bartered throughout the Mediterranean area. One of the precious exhibits in the British Museum, London, is a life-sized human skull, perfect in detail, which was carved from a clear quartz crystal by an Aztec craftsman. Japanese embroidery workers still imagine that the crystal will keep their hands cool. The American Indian cut quartz crystals into ceremonial pieces, drills, arrowheads, and spears.

Oriental lapidaries are credited with the first crystal-gazing ball. Many rulers staked the fate of their countries upon what could be seen in a ball with much the same dependence that Hitler places on astrology. Some people still believe that the highly polished spherical surface reflects light points, holding the gazer's eye until he becomes subconscious and enters the psychic world.

(Continued on page 3, col. 1)



Less than one per cent of all crystals found have any commercial value. (Courtesy of the Diamond Drill and Carbon Company).

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Fields of Work
Geotechnology.

Earth Sciences: Geology, Mineralogy, Geography, Geophysics, Meteorology, and related subjects. **Mineral Economics:** Economics and conservation of minerals. **Mineral Engineering:** Mining Engineering, Mineral Preparation, and Petroleum and Natural Gas Engineering. **Mineral Technology:** Fuel Technology, Metallurgy, and Ceramics.

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MARCH 1944

TRENDS and OBJECTIVES

BY DEAN EDWARD STEIDLE

IMPACT OF GEOGRAPHY

GLOBAL WAR has made geography's place in higher education secure. World War I gave impetus to geography as a college subject, but it was still much under-developed, and prior to the Japs' attack on Pearl Harbor, relatively few colleges included it in their curricula. With the inauguration of the Army and Air Force training programs, however, the subject gained new stature and was added to the curriculum of literally hundreds of colleges and universities.

Geography on a university level is a distinct field concerned with the earth's regions and the individual elements, natural and cultural, of which they are composed. The most valuable single course for the average college student would consist of a regional world survey to provide an up-to-date picture of the various countries, considering in a general way such basic factors as climate and topography but emphasizing particularly man's distribution, activities, and problems. Such a course is an ideal foundation for many other college subjects. For example, it is excellent background for work in history. Some of the most glaring errors made in the New York Times history test were due primarily to a lack of knowledge of geography.

An Atlas of World Maps recently issued by the Army for use in the Army Specialized Training Program at the colleges illustrates the significance now attached to geography. The atlas, which measures 10½ inches by 22 inches, consists of a text of between 15,000 and 20,000 words and 30 full-page maps. These cover land forms, climate, soils, natural vegetation, population distribution, languages, agricultural regions, mineral resources, and a variety of other topics.

The maps were prepared by the geography staff of the Department of State, assisted by several other geographers. They are excellent jobs, with a precision of drawing and a delicacy of color that would be beyond the budget of the ordinary commercial atlas maker. It is unlikely that the average trainee will appreciate the high quality of workmanship and information represented, and the atlas is likely, in the long run, to make its greatest appeal to the teacher and research worker.

Particularly significant in the new geography atlas is the extent to which minerals are stressed. One-third of the maps deal with the mineral industries, apparently in recognition of the extremely important role of mineral resources in current political geography. This point has been emphasized by C. K. Leith, the well-known mineral economist, who points out that potential world control lies in the control of mineral resources rather than in control of any of the great land masses. It is significant, too, that a joint session was devoted to postwar mineral control at the recent annual meeting of the American Institute of Mining and Metallurgical Engineers, New York.

The School of Mineral Industries is planning an intensive expansion of its program in geography, including cartography, in the postwar period. The expansion concerns all three functions; namely, resident instruction, extension and correspondence instruction, and research.

Blending coal, like blending coffees, is done to improve quality. Coals of various types, grades, and ages from various mines, or even from the same mine, are scientifically mixed to insure obtaining a coke of uniform size, ash, and sulphur content.

CERAMICS

Dr. Edward C. Henry, Associate Professor of Ceramic Engineering, has been appointed Acting Head of the Department of Ceramics. As stated here in an earlier issue, Dr. N. W. Taylor, head of the department since 1933, has accepted a position with the Minnesota Mining and Manufacturing Co., St. Paul, Minn. Dr. Henry has been on the staff of this department since 1936 and previously was an instructor and senior research fellow at Rutgers University.

The ceramics department staff is in active correspondence with many of the recent graduates of this curriculum in the armed forces. A letter has just arrived from Lt. W. H. Orth, U.S.M.C.R., a member of the class of 1941 who is stationed in the South Pacific. He reports that a copy of Mineral Industries was the first mail he received after his company's landing on an island recently in the news as a scene of intense fighting.

Dr. W. A. Weyl presented a paper on "Some Lesser Known Properties and Uses of Phosphates" before the American Institute of Mining and Metallurgical Engineers on February 21. A summary of this paper follows:

Most of the better known uses of phosphates are based on their distinctive chemical properties. It is the aim of this paper to point out a few of the lesser known properties and uses of phosphates where the chemistry of these compounds plays only a secondary role but where the characteristic features are brought about by the geometry of the atomic structure.

Certain phosphates form long chain molecules which have many properties in common with the high polymers of organic substances. The preparation of a rubber-like complex phosphate is described and its structure discussed.

Phosphorus pentoxide as well as many phosphates form glasses. The structure of these glasses is compared with that of silicates. Several properties and applications of these phosphate glasses are discussed.

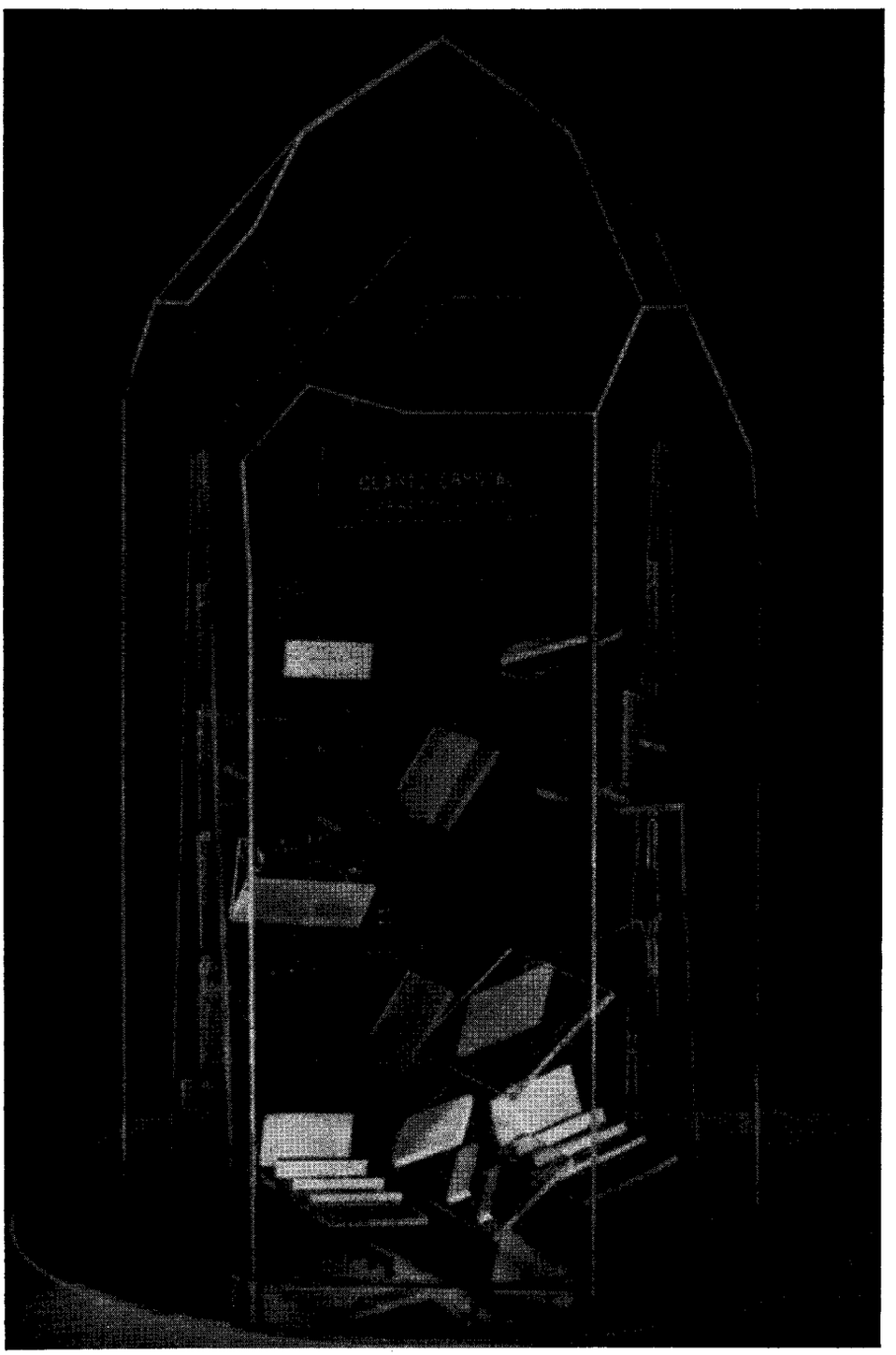
Among the crystalline phosphates, the natural and artificial minerals possessing apatite structure are particularly stable. Based on the tendency of phosphates to form apatite and the stability of the latter, the following uses are briefly discussed: defluorination of water, apatites as host lattices for fluorescent materials, and opacifying agents for milk glasses.

Strategic Mineral

(*Continued from page* 1, *col.* 3)

Clear quartz crystals are often ground into lenses and prisms for optical instruments and spectacles. A camera lens cut from a crystal of a specific yellow tint is reported to give results superior to a glass lens used with a color screen. Fused quartz has a quality stranger still. A bar of this material bent in a curve will bend light rays and carry them around corners.

The Brazilian crystals are mined in the tropical State of Minas Gerais. They are found either in old veins or in gravel beds of prehistoric rivers. In the latter instance, the crystals are usually rounded by water action. The operations consist of small, scattered, primitive open-pits, usually employing hand labor. Crystals are hand picked at the pit. The Office of Economic Warfare maintains a laboratory in Rio De Janeiro where the crystals are chipped and tested under the scorching rays of arc lamps and polarized light before being approved for shipment to the United States. In this country they are checked with the x-ray and other instruments of precision and then sliced into small thin plates. The technique is as intriguing as the splitting of a diamond. Less than one per cent of all crystals found have any commercial value.



A quartz crystal can be sliced at many different angles to produce oscillator plates of different characteristics. (Courtesy of the Bell Telephone Laboratories).

These four piles of assorted age-worn crystals may represent the entire day's production of one thousand miners. (Courtesy of the August E. Miller Laboratories).

The chief use for Brazilian quartz crystals in this war is in radio oscillators. Small wafer-like plates are used in transmitters and receivers to control frequency transmission in all radio sets, down to walkie-talkies. Because of the "piezo-electrical" property of quartz, announced by Pierre and Jacques Curie at the Sorbonne in 1880, the oscillator vibrates only to its assigned frequency, depending on the thickness to which it has been ground. A crystal can be sliced at many different angles to produce oscillator plates of different characteristics. In the hubbub of radio communication between tanks on the field of battle, among a squadron of bombers or a pack of submarines, it is the mysterious quartz crystal that makes sensible intercommunication and co-ordination of effort possible.

The quartz crystal industry was wholly unorganized when the Japs struck at Pearl Harbor. Our Dr. William Parrish, specialist in x-ray crystallography, was one of the very first members of the faculty of the College to be called into service by our Government. He aided in organizing the industry and in preparing specifications and standards. Through the courtesy of August E. Miller Laboratories, Bell Telephone Laboratories, and Diamond Drill & Carbon Company, a set of specimens illustrating the evolution of a quartz oscillator plate has been placed on display in the Mineral Industries Building.

The Ohio River once flowed north up the Beaver Valley and out the Grand River into Lake Erie. Its course was changed during the Glacial Period.

FUEL TECHNOLOGY

The stoker research laboratory held an open house on December 7, 1943, in connection with a joint session of the Centre County Engineers' Society and the Central Pennsylvania Section of the American Society of Mechanical Engineers. A. W. Gauger addressed the joint meeting in the evening, illustrating his remarks with colored movies of fuel beds in domestic stokers.

October 1943 Graduates in Fuel Technology

William Gotherman and Henry Mumper are employed as Research Assistants in the stoker research laboratory of the Department of Fuel Technology.

Alton Letzler has received orders to report to the Navy Midshipman School at Notre Dame University for training leading to a commission.

Alfred Metzger, also a member of the Navy V-7 program at the College, is working for the U. S. Bureau of Mines at Martinsburg, Pennsylvania, while waiting for orders.

Robert Speidel reported for midshipman training at the U.S.S. Prairie State in New York, where he is undergoing the indoctrination training previous to being commissioned.

Lloyd Zimmerman is employed in the by-product plant of the Pittsburgh Coke and Iron Company's plant on Neville Island, Pittsburgh.

The quarterly meeting of the Bituminous Coal Research Advisory Committee was held in the School of Mineral Industries on January 21, 1944. Progress in research on the single retort stoker was reported on and future plans were discussed. Results of tests on the Pennsylvania domestic stoker were presented.

The Pennsylvania Grade Crude Oil Association Production Research Advisory Committee met at the College on January 5 and 6.

The Secondary Recovery Research Staff reported on progress and the future program was discussed. In attendance were: Mr. Wilson K. Page, Chairman, Olean, New York; Mr. R. B. Bossler, Oil City; Mr. C. C. Hogg, Titusville; Dr. Parke Dickey; and Mr. D. T. Andrus, President, Pennsylvania Grade Crude Oil Association, Bradford, Pennsylvania.

A. W. Gauger, Director of Mineral Industries Research, addressed the annual meeting of the Coal Mining Institute of America at Pittsburgh, Pennsylvania, December 9, 1943, on the subject of "Coal as Related to the Liquid Fuels Industry."

EARTH SCIENCES

Professors Chesleigh A. Bonine, William M. Myers, and Paul D. Krynine attended the meetings of the American Institute of Mining and Metallurgical Engineers and the Society of Economic Geologists held in New York City February 20 to 25.

PETROLEUM AND NATURAL GAS

Carlos Lara, the Gulf Oil Co., is working in the San Tome region of Venezuela at present.

Dave Landers is believed to be in the army. Earl M. Lightner is a private in the Army and his address is A.S.M. 33874040, Co. D. 6 Bn E.R.T.C., Fort Belvoir, Va.

MINING

Penn State mining engineers serving in the armed forces on the various world-wide battle fronts are having many interesting experiences. Lt. J. M. Hackett, '41, O-1105483, 849 Eng. Avn. Bn., APO 689, care Postmaster, New York City, writes:

"A couple of months ago I met a British Sales Manager for a coal mining company, not so far from here and he took me through the mine. It was a large mine but production was small compared with the outlay of the whole thing. It was a soft coal mine, and the seam pitched about 45° and is being mined quite similar to the lower hard coal mines at home. I think you would enjoy working at the mine for they have women doing the outside work, and up till 1926 had them working inside, but the Government decided it wasn't a good idea. The mine foreman said it was then that India lost its best miners. The average wage is about 20 cents a day. They use safety lamps for light; many of the miners work naked; never heard of safety shoes or hard hats; the inside temperature was 83° the day I was in, and the air was very poor. The foreman said they cut down on the supply of oxygen because of the numerous fires that broke out in the mine. The U. S. Bureau of Mines would have a field day if they ever ran across a mine like this.

"The vein of coal is 60 feet thick—they entered it by driving twin tunnels, on a water level, from the lowest point in a valley through the mountain to meet the vein. They have eight levels from the tunnel up to the top and do their development on the way up and final mining on the way down. The water, which is plentiful, drains by gravity. The coal is extremely soft and wet. It is high in sulphur and therefore not suited for metallurgical purposes and it runs around 14,000 Btu."

Geared for War

From the Hanna Coal News, St. Clairsville, Ohio, November 1943.

Coal wears no uniform.

It goes off to the wars in the same garb in which it sees the light of day.

It needs no training, no fundamental change to ready it for its job—and it goes to work with equal readiness in small grates or modern, super-efficient, monster industrial furnaces.

And for all its man-made difficulties, coal itself is doing its full part to help win the war.

It was on the job when the first bomb hit Pearl Harbor and will still be there when the last fighting man steps off the train at his home station.

Today it develops more power—hauls more trains—warms more homes, offices and buildings—turns more wheels—generates more light and power than any other fuel—and does it at a lower cost.

Though the armed forces and other war industries have drawn some 70,000 trained men from the mines, more coal was brought to the surface in 1942 than in any previous year.

Again in 1943, the first nine months of the year set a new record for coal production, topping any like period in history.

Coal is "public energy No. 1," now as in the past—and those who produce it work shoulder to shoulder with other American industries in an honest effort to meet their every obligation as employers, as suppliers to the public—and as good citizens.