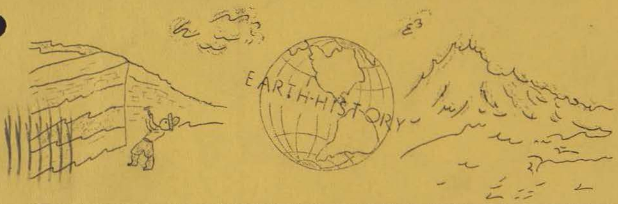

THE MINNESOTA GEOLOGIST

OFFICIAL BULLETIN OF THE GEOLOGICAL SOCIETY OF MINNESOTA

Vol. VI SEPT. 1949 OCT. No. 4

ONE TOUCH OF NATURE MAKES THE WHOLE WORLD KIN.

Shakespeare -
Troilus and Cressida, iii.3

GEOLOGICAL SOCIETY OF MINNESOTA

EDITORS
Loretta E. and E. L. Koppen
3376 Brunswick Ave.,
Minneapolis 16 Minn.

The Society is devoted to the study of GEOLOGY, MINERALOGY, and PALEONTOLOGY for their cultural value.

OFFICERS

MEETINGS : October to May inclusive, 7:45 P. M. every Monday not a holiday, auditorium, Minnesota Museum of Natural History, University of Minnesota, 17th Ave., S. E. and University Avenue.
Visitors welcome.

FIELD TRIPS : May until October inclusive.

ANNUAL DUES : Residents of Hennepin and Ramsey counties $ 3.00 plus $ 1.00 additional for husband, wife, or dependent family members ; for students and non-residents, $ 1.00.

MEMBER

MIDWEST FEDERATION OF GEOLOGICAL SOCIETIES

* Deceased

EDITORS MEMO :

We are pleased to announce that after many months of planning and work the first Geological bronze tablet to be erected by our Society, in Minn., is ready and will be mounted in granite by the State Highway Dept. at an outlook on the St. Croix at Taylors Falls. This sign will be dedicated to the memory of our founder, Edward P. Burch. A dedicatory program and field trip will be held on Sunday, October 30.

Mr. Lawrence W. King, with the help and co-operation of Dr. George A. Thiel, Chairman of the Department of Geology at the University of Minnesota who compiled the geological data, also made all other arrangements. We the members can be justly proud of supporting this worthwhile project. This, we hope, is the first of similar signs to be erected throughout the state by our Society.

MIDWEST FEDERATION CONVENTION.

The Midwest Federation of Geological Societies held its annual convention on the 26th and 27th of August at Davenport Iowa. There was a good representation from nine states of the midwest, there now being ten states included in the Federation. The Federation has been steadily growing, seventeen societies being affiliated in the Federation. Two of the largest societies are from Minnesota i.e. The Geological Society of Minnesota, and the Minnesota Mineral Club, each of which had three delegates to the convention.

The features of the convention program were -

1st, A visit to Augustana College, across the river in Rock Island.
2nd, A visit to Black Hawk State Park where an evening meal was enjoyed in the beautiful new Stone Chalet and Museum.
3rd, Lectures on Geology, Mineralogy and Lapidary Work.
4th, Evening banquet and auction sale, the largest yet held in the midwest.
5th, The most complete exhibit of mineral specimens yet held in the Federation.
6th, The Sunday excursion to some of the famous collecting areas in Iowa.

The following officers were elected for the ensuing year. President, Charles H. Preston, Minneapolis ; Vice President, Jas. O. Montague, Milwaukee ; Secretary, John F. Mihelcic, Detroit ; Treasurer, Herbert W. Ward, Des Moines ; Historian, Ben Hur Wilson, Joliet.

A constitution was adopted and incorporation was authorized to be organized in the state of Minnesota. Due to the fact that a preponderance of affiliated societies are interested mainly in minerals and lapidary work, the name was changed to read "Midwest Federation of Geological and Mineralogical Societies." The by-laws provide for an executive committee to conduct the detail affairs of the Federation to be appointed by the President.

Such committee was later appointed, consisting of Wilson, Joliet ; Scanlon, Chicago ; Grand-Girard, Evanston ; Montague, Milwaukee ; and Bingham, St. Paul. This committee held a session in Milwaukee on the 29th and 30th of September and made arrangements for space in the Milwaukee Municipal Auditorium for June 28, 29, and 30, 1950. The committees are all enthusiastic in regard to the "set up" and look forward to a most successful convention next year. This will be a joint annual convention of the Midwest Federation (the 10th) and of the National Federation (the 3rd.)

We must all get behind this project to assure its success.

Charles H. Preston.

In Memoriam

Mrs. Lillian J. Freeman who passed away on August 30, 1949, was born in Detroit, Mich. October 20, 1867.

Her mother died when she was a little girl so she often accompanied her father on business trips. She told of him leaving her at the Field Museum for hours at a time and that is when she first became interested in geology and mineralogy.

She was married to Herbert G. Freeman in 1891. In her busy life she managed to attend the University of Minnesota, studying art, speech, psychology, music, etc. She graduated at the age of 65. Mrs. Freeman retained an active mind and boundless enthusiasm to the very last.

She was keenly interested in people and their welfare, and was, in her quiet considerate way quite a philanthropist. While she was attending the University and in the years that followed, she helped many a struggling student who ran short of funds. A former Minneapolis resident owes his start as an operatic singer to her generosity and encouragement.

During World War one she gave very freely of her time, talents and energy. She used to make trips every week to Fort Snelling to entertain and talk with the boys and also taught them dancing. Many of the boys gave her their medals in appreciation for her untiring devotion and service.

Her husband died about five years ago. Surviving are a son Kenneth, Oakland Calif. and one brother, S. S. Elliot, Portland, Oregon.

Mrs. Freeman was a member of the University of Minnesota Cosmopolitan Club, Hennepin County Historical Society, the Minnesota Mineral Club and the Geological Society of Minnesota. She had many friends in the society and they will regret her passing.

Emma Cooper.

EDITORS NOTE : The following article was written by Dr. Leslie O. Dart, one of our Society's most popular and best known members.

The term, atmosphere, almost always refers to the gaseous envelope surrounding the surface of the earth. The word is derived from a Greek word meaning smoke or vapor and sphere.

The early Greek, Anaximander described the wind as being flowing air.

It is said that in the early part of the 17th century the Arabs estimated the height of the atmosphere from the duration of the twilight as 92 kilometers, or about 5¾ miles. Scheele (1772) recognized that air consists chiefly of two gases. Cavendish, in 1781, found air to be a mixture of 20.83 parts oxygen and 79.17 parts nitrogen. In 1846 Bunsen definitely established the fact that the composition of air is not absolutely constant. However back in 1785 Cavendish noted that air contained a gas or gases that did not conform to tests for oxygen or nitrogen. In 1894 Lord Rayleigh and Sir William Ramsey isolated an inert gas and they named it argon.

Ozone in the air is produced by electrical discharges and is more abundant in the air over seas and mountains, but it probably is never present in quantities. Its odor, that of freshly laundered sheets that have been hung out in the sunshine to dry, is often distinguished in the air following an electrical storm.

Carbon dioxide is the product of espiration in animals and plants, and large quantities of this gas, steam, hydrogen and nitrogen are liberated to the air by volcanoes.

The source of oxygen is not so definitely known. It might be from the decomposition of volcanic carbon dioxide by plants, but only green plants in the presence of light can decompose carbon dioxide. Most primitive plants were not green, so it seems more probable that there may have been an excess of oxygen in the first place. However the balance of the quantity of oxygen in the air at the present time is maintained by green plants.

The lighter gases, such as helium and hydrogen, would largely escape if the earth was in a liquid state but would be retained by a solid earth crust.

Among the atmospheric gaseous impurities are nitrogen compounds that are produced by electrical discharges during thunder storms. These are washed out of the atmosphere and carried down by rain and appear to play an important role in fertilizing the soil, thus explaining the oft noted fact that rain appears to revitalize the lawn and garden much more than wetting down the lawn or garden from the hydrant.

Inorganic dust is introduced into the atmosphere by disintegration of meteors, volcanic explosions, combustion of fuel, and from the earth's surface by winds. Minute salt crystals are often found that were introduced by ocean spray. Our lips taste salty when we are near the seashore.

It is thought that some atmosphere extends upward altogether some thirty-five miles or more, the troposphere about six miles, the stratosphere thirty or more miles.

Permanent constituents of air are usually present in such amounts as give the average figures in the following table.

Dry air, volume per cent

Nitrogen	75.03
Oxygen	20.99
Argon	0.9323
Water vapor (variable)	
Carbon dioxide	0.03
Hydrogen	0.01
Neon	0.0018
Krypton	0.0001
Helium	0.0005
Ozone	0.00006
Xenon	0.000009
Radon	0.0000001

Percentages of the consitutients of the atmosphere vary with latitude, altitude and with local atmospheric disturbances. And besides the elements named, there are always impurities, foreign matter, to be considered, and the amount of impurities present is predicated on local conditions. These impurities are both organic and inorganic, the former often being living organisms, bacteria, the latter, as well as the former, may be largely composed of finely oxidizedmaterial. Over the seas the number of tiny particles might be one to one cubic centimeter while over cities there might be thousands of foreign particles to one cubic centimeter.

The Austrian meteorologist, Julius Hann, has shown the considerable variation in atmospheric constituents by latitude in the following table.

	Nitrogen	Oxygen	Argon	Water vapor	Carbon dioxide
Equator	75.99	20.44	0.92	2.63	0.02
Latitude 50 N.	77.32	20.80	0.94	0.92	0.02
Latitude 70 N.	77.87	20.94	0.94	0.22	0.03

The average water vapor in the air in summer is about 1.2 % by volume, but in very cold weather the amount present falls almost to zero, and in humid climates it may reach as high as 5 %.

Air dissolves in water, and air expelled from water contains an increased proportion of oxygen. This is the reason that automobiles run smoother and have more power in foggy weather, combustion being much better because of the increased amount of oxygen in the in-taken air.

This table gives the names and the approximate percentages in the earth's crust of the most abundant elements. (Data of Geochemistry. U.S.G.S. Bull. 770.)

Oxygen	46.46 %	Hydrogen	0.14
Silicon	27.61	Phosphorus	0.12
Aluminum	8.07	Carbon	0.09
Iron	5.06	Manganese	0.09
Calcium	3.64	Sulfur	0.06
Magnesium	2.07	Chlorine	0.05
Sodium	2.75	Barium	0.04
Potassium	2.58	Fluorine	0.03
Titanium	0.62	Strontium	0.02

BULLETIN BOARD

Oct. 24 --- Taylor's Falls, Gooseberry, and Baptism River State Parks and their Land Forms.
Dr. Geo. M. Schwartz, Prof. of Geology, Univ. of Minn., and Director Minnesota Geological Survey.

Oct. 31 --- Minneopa and Ramsay State Parks.
Mr. Ernest H. Lund, Graduate Student and Instructor, Department of Geology, University of Minnesota.

Nov. 7 ---- Land Forms and Scenery.
Mr. J. Merle Harris, Instructor in Natural Science, General College of the University of Minnesota.

Nov. 14 --- The Earth and Its Climates.
Dr. John R. Borchert, Assistant Professor, Department of Geography, University of Minnesota.

Nov. 21 --- Introducing Minnesota Geology.
Dr. Geo. A. Thiel, Prof. of Geology and Chairman of Geology and Mineralogy, Univ. of Minnesota.

Nov. 28 --- Minnesota and the World's Oldest Rocks.
Dr. Geo. M. Schwartz.

Dec. 5 ---- The Ancient Iron Formations of the Lake Superior Region.
Dr. John W. Gruner, Prof. of Geology and Mineralogy, Department of Geology, University of Minnesota.

Dec. 12 --- Origin of the Lake Superior Basin.
Dr. Geo. M. Schwartz.

Dec. 19 --- The Cambrian Rocks of Minnesota.
Mr. Robert Berg, Graduate Student in Geology, Univ. of Minn. doing field work on the Cambrian under the sponsorship of the Geological Society of Minnesota.

Jan. 9 ---- The Cambrian Rocks of Minnesota. (Cont'd.)

Jan. 16 --- The Ordovician Rocks of Minnesota.
Dr. W. Charles Bell, Associate Prof. and Curator Geologic Museum, Dept. of Geology, Univ. of Minn.

Jan. 23 --- The Ordovician Rocks of Minnesota. (Cont'd.)
Dr. W. Charles Bell.

Jan. 30 --- The Devonian and Cretaceous Rocks of Minnesota.
Dr. Geo. A. Thiel.

THE SEARCH FOR URANIUM

by

W. S. SAVAGE.

Ontario Department of Mines

Part one of a three-part article.

Note : Published by permission of the
Deputy Minister, Ontario Department of Mines.

INTRODUCTION

Uranium was discovered by Martin Klaproth in 1789, and the element was isolated in its metallic form for the first time by Eugene Poligot in 1847. The hitherto unsuspected property characteristic of all uranium-bearing minerals and now known as "radioactivity" was discovered accidentally by Prof. Becquerel in Paris in 1896.

Becquerel, who was experimenting with fluorescent minerals, happened to place a piece of uranium-bearing mineral on a wrapped photographic plate in one of the drawers of his desk. Some time later he used the photographic plate and on developing it was astonished to find an image of the mineral specimen. Only an invisible penetrating radiation could explain this phenomenon, and Prof. Becquerel gave the problem of its investigation to one of his pupils, Marie Curie. Madame Curie and her husband Pierre found one other element, in addition to uranium, that was radioactive. This element was thorium, and the Curies were soon able to show that the capacity to fog a photographic plate in the dark was proportional to the uranium or thorium content of the mineral, depending on which it contained.

There was one exception. This was the black mineral pitchblende, which, though it contained uranium, showed a radioactivity much more powerful than could be accounted for by its uranium content. The Curies suspected another much more powerful radioactive element closely associated with uranium, occurring as a very trifling percentage of the whole in the mineral pitchblende. After several years of painstaking work, the Curies succeeded in isolating a very minute quantity of this element, to which they gave the name "radium." The proportion of radium to uranium in pitchblende is one third of one part per million.

The therapeutic value of radium was soon recognized by the medical profession, and for many years uranium-bearing minerals were mined for their radium content. The extensive carnotite deposits in Colorado and Utah were exploited for a number of years, yielding uranium (for the radium content) and vanadium. The very rich deposits of pitchblende in the Belgian Congo were first discovered in 1913 and proved to be so rich that it was no longer possible for the carnotite deposits in the United States to compete on a commercial basis. The pitchblende deposits of Great Bear lake in Canada were discovered in 1930, and these in turn proved more economical to mine than those of the Belgian Congo. In the process of extracting radium from these uranium ores, the tailings that contained uranium were often sold as by-products, if they could be sold at all, or were dumped outside the refineries.

Most persons by this time know that the element uranium has played the chief role in the development of the atomic bomb, and the public has been made amply aware, through the press and radio, of the enormous significance that the discovery of means for releasing nuclear or atomic energy must inevitably have in the general world economy. It follows, therefore, that the provision of greatly increased supplies of uranium has become a matter of paramount importance. Every nation on earth, large and small alike, is now engaged in a feverish search for uranium resources. Politically, the nation that has large reserves of uranium ore assumes a stature far out of proportion to mere size, or population, or wealth.

The element uranium, being a metal, occurs in minerals and ores in the same way as copper, iron, lead, zinc, or any of the other metals commonly used in industry, and the same fundamental principles that have been successfully applied in prospecting for these other metals are equally applicable to the search for uranium ores.

URANIUM AND THORIUM MINERALS

It is not generally realized that uranium is not a rare element, being more abundant in the earth's crust than silver, antimony, and mercury combined. The content of uranium in the earth's crust is 4 parts per million and of thorium is 11.5 parts per million. It must be pointed out, however, that relative abundance is not necessarily indicative of availability. Unlike many elements uranium is not widely found in rich bodies, and it may be intimately associated with other chemical relatives in igneous rocks.

All rocks contain perceptible amounts of radioactive elements, i.e. measurable quantities of uranium and thorium minerals. The more acidic, light-colored igneous rocks, such as the granites and the rhyolites, contain from 10 to 20 grams of radioactive elements per ton, of which about 25 percent is uranium and the remainder thorium. The more basic and darker igneous rocks, such as basalt, have only from 3 to 8 grams of radioactive elements per ton.

Uranium-bearing minerals are distributed throughout the world with practically every country having one or more known occurrences. In most cases these deposits are only of minor importance compared with those that have been mined on a commercial basis for radium and uranium. It was estimated in 1941 that about 75 per cent of the known reserves of uranium was in the hands of the United Nations. These reserves include the well-known deposits of Canada, the Belgian Congo, and the United States.

There are many low-grade deposits of uranium minerals that have received little attention. Under conditions of mining uranium ores solely for the radium content, low-grade deposits obviously could not enter into the picture. With the development of the atomic bomb and the possibility of using nuclear energy for power purposes, it is very likely that all low-grade deposits of an extensive nature will be carefully investigated.

The number of known minerals that contain uranium in some measure is quite large, but most of these are rare and the content of the element is so low and variable that these minerals are of little practical importance as a source of uranium. The bulk of the world supply of uranium up to the present has been obtained from deposits of the following minerals :-

Pitchblende (crystal variety uranite) - Primary mineral.

Carnotite - Tyuyamunite   Secondary minerals.
Autinite - Tobernite

Pitchblende, which is a natural uranium oxide, is the richest and commercially the most important ore of uranium. It is the only primary uranium mineral that occurs in the form of definite veins or lodes. It may be the dominant mineral or it may occur as an accessory in veins of other metallic ores, notably those of silver, cobalt, and nickel. Pitchblende is generally deposited from hydrothermal solutions in the form of veins or stringer systems occupying faults, shear zones, or fractures, but some disseminated pitchblende may occur in the wall rocks. In this form concentrations of pitchblende are comparable in many respects to common types of gold and base-metal deposits, and the same considerations of geological structure that guide prospecting for th these deposits will aid materially in the search for pitchblende.

In his paper on "Prospecting for Uranium in Canada," Dr. A. H. Lang, of the Geological Survey of Canada, stresses the fact that as the minerals with which pitchblende is associated in Canadian hydrothermal deposits vary greatly in kind from one property to another, no definite rules for mineral associations can be made. At several properties, pitchblende is cobalt or cobalt-nickel minerals, chalcopyrite, pyrite, hematite, quartz, and various carbonate minerals. The extent to which these associations are accidental and the extent to which they are reliable guides to prospecting are not well known at present.

Pitchblende is characterized by black color, metallic appearance, greasy or pitchy lustre, dense massive texture, and exceptional weight. It sometimes occurs in botryoidal or kidney-like masses or crusts, which under a lens are seen to have a radiated texture. In this last form, pitchblende somewhat resembles hematite, with which it is often closely associated, but it may readily be distinguished from hematite by the black or greenish-black color of its streak or powder, in contrast to the strong red color of hematite.

Pitchblende deposits have been found in so many different types of rock that no general rules for favorable host rocks can be given. The problem is peculiar to individual districts, and even in these, geological structure is commonly more important than rock types.

Almost all the other primary uranium minerals, including "uraninite," a crystal variety of pitchblende, are confined in their occurrence to granitic rocks, more especially to pegmatite. The variety of uranium minerals found in such association is large, and for the most part these minerals are of complex composition. They are mostly black or dark brownish-red in color, conspiciously heavy, and often of a submetallic appearance, and they sometimes occur in well-developed crystals. As a rule, such minerals occur rather sparsely disseminated in the host rock, though occasionally they form small nests or pockets, or are concentrated in zones containing large aggregates of black mica. Such deposits occur in widely separated parts of Canada, but particularly in the southern part of the Canadian shield. None of these has yet been proved to be a commercial source of uranium. The occurrence, also, of a black, coal-like hydrocarbon mineral (thucholite or anthraxolite) which will burn, in a pegmatite is suggestive of the presence of uranium, and this material itself often contains a considerable amount of the element.

Primary uranium minerals are rather prone to alteration and breakdown under weathering agencies, and for this reason they are seldom likely to be found with their fresh outward characteristics preserved in surface outcrops. Pitchblende, as well as its crystal variety uraninite, may weather to a greenish cast, but both are more likely to exhibit characteristic and vividly colored yellow and orange secondary products.

Secondary uranium minerals are those formed by the alteration of primary species by weathering or other natural agencies. They may be found replacing the original minerals in situ, but more commonly have been precipitated out of solutions derived from such minerals. The dissolved uranium salts may have been carried considerable distances by circulating or surface waters with the formation of rich concentrations in certain favorable areas, such as the deposits of "carnotite" in Colorado and Utah.

Deposition from solution may have also occurred adjacent to the primary source, on cracks and joints in the enclosing rock. The "torbernite-autunite" deposits of South Australia and Portugal are examples of this type of deposition. These two species, the so-called "uranium micas," are the only secondary uranium minerals that commonly occur in crystal form. They occur in small, brittle, cleavable plates, which for torbernite are of an emerald-green color and for autunite are bright lemon-yellow.

Carnotite (potassium uranyl vanadate) is by far the most important uranium-bearing mineral found in the United States. It most frequently occurs as a yellow crystalline or amorphous powder in loosely cohering masses. In the Colorado and Utah deposits the carnotite occurs chiefly in sandstone, concentrated along cracks or bedding-planes or in pockets, and less commonly as an impregnation. Tyuyamunite is a variety of carnotite found in Russia in which calcium takes the place of potassium.

There are a large number of other species of secondary minerals in which the salts of uranium and various other metals are combined. These minerals for the most part occur as either powdery coatings or soft massive material. Intense and vivid colors, in shades of bright yellow, orange, and green, are the chief distinguishing features of such minerals and serve at once to attract attention to them.

A tropical climate is necessary for the formation of important deposits of secondary uranium minerals, and it is unlikely that occurrences of this nature will be found where recent glaciation has removed much of the original surface. Such minerals, however, are very important in that they may serve, even in small traces, as indicators of the possible nearby presence of primary ore.

NEXT MONTH : Part Two

Prospecting for Radioactive Minerals,

and the Geiger Counter.

WILMA MONSRUD
5255 DUPONT AVE. N.
MINNEAPOLIS 12, MINN.

MINNEAPOLIS MINN.

MINNEAPOLIS MINN.