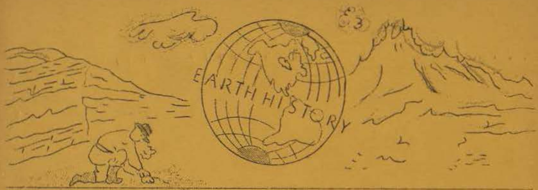

THE MINNESOTA GEOLOGIST

OFFICIAL BULLETIN OF THE GEOLOGICAL SOCIETY OF MINNESOTA

VOL. XII 1955 WINTER 1956 NO. 2

GREATER EVEN THAN THE GREATEST DISCOVERY IS
TO KEEP OPEN THE WAY TO FUTURE DISCOVERIES.

Dr. John Abel.

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MEETINGS: October to May inclusive, 7:30 P.M. every Tuesday not a holiday, Auditorium, Minnesota Musuem of Natural History, University of Minnesota, 17th Ave., S.E. and University Avenue. Visitors welcome.

FIELD TRIPS: May until October inclusive.

ANNUAL DUES: Residents in a 50 mile radius of the Twin Cities $ 3.00 plus $ 1.00 additional for husband, wife, or dependent family members, for students and non-residents, $ 1.00.

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LECTURES TO BE GIVEN BY DR. SLOAN.

January 24	Evolution of Phylum Mollusca.
January 31	Evolution of Trilobites and Brachiopods.
February 7	Evolution of Vertebrates.
February 14	Early Paleozoic History.
February 21	Late Paleozoic History.
February 28	Mesozoic History.
March 6	Cenozoic History.
March 13	Pleistocene History.

This concludes the series of lectures by Dr. Sloan.

March 20	Minnesota's Energy Resources. by Dr. John R. Borchert, Climatologist at the University.
March 27	Geological Setting of Taconite. (Accompanied by colored motion pictures). by Dr. Donald H. Yardley of School of Mines.
April 3	A repeat lecture on "Earthquakes" given several years ago. by Dr. Harold M. Mooney, of School of Mines.
April 10	Search for Uranium in Wyoming and Utah. by Dr. John W. Gruner, of the Department of Geology U. of M. This will be a discussion in connection with Dr. Gruners work for the Atomic Energy Commission.
April 17	The Factors Which Have Influenced the Location of Industry in Western Europe. by Mr. John W. Webb of the Department of Geography U. of M.
April 24	Annual Geological Society Banquet. Dr. Herbert E. Wright of the Department of Geology will give an illustrated talk on the Near East with emphasis on the Archeological features of that region.

TWO WEEK FIELD TRIP FOR 1956.

The two week field trip for 1956 is scheduled to begin on Saturday, July 14 and return to Minneapolis on Sunday July 29. The trip will include as overnight stops:

Kadoka S. D.	Gillette Wyo.
Mobridge S. D.	Butte Mont.
Bozeman Mont.	Lewiston Mont.
Missoula Mont.	Ephrata Wash.
Spokane Wash.	Mount Ranier Wash.
West Glacier Mont.	Browning Mont.
Cour D'Alene Idaho	Glendive Mont.

Highlights of the trip will be a trip into a copper mine, copper refinery electrolytic copper refiner, sawmill, Grand Coulee Dam, Mount Ranier, Glacier Park, in addition to the general geology of the route passed over.

Reservations for the trip can be made with Dr. Bert Carlson, 3034 46th Ave. So., Minneapolis 6, Minn. Further announcements will be made by mail.

A meeting of the prospective field trip leaders was held on January 20th and a tentative schedule of field trips was drawn up. There is every indication that this will be one of the most interesting field trip seasons in the history of our Society. The first field trip date is tentatively set for May 6th.

The American Federation of Mineralogical Societies will meet in St. Paul and Minneapolis for their annual convention this summer. The dates are July 12 through 15th. The Midwest Federation and the Minnesota Mineral Club are hosts. The meetings and exhibits will be at the Minnesota State Fair grounds.

We wish to welcome the following new members into

THE GEOLOGICAL SOCIETY OF MINNESOTA

Bruning, Geo. J.	CH 4032	4334 Penn Ave. N.,	Mpls.
Clayton, Mr. & Mrs. Temple (& family)	IV 4-3805	2800 Edgerton St.	St. P 9
Johnson, Mrs. Evelyn (& Thomas)	VI 4-1121	1974 Reaney Ave.	St. P 6
Luce, Dan F.	KE 3341	1821 So. Emerson	Mpls.
Osborn, Mr. & Mrs. Robt (& family)	JU 4874	5556 No. Emerson	Mpls.
Quimby, Joy	HA 1-1209	312 Fremont	Anoka.
Rauch, John Bruce		514 6th St. S.E.	Mpls. 14
Rovainen, Carl	Rte. 3, Box 763		Excelsior
Shoemaker, Mary Lou	LO 9578	4034 2nd Ave.	Mpls.
Squires, Wenonah (Miss)	HAL 2705	2228 Ferry	Anoka.
Wolalager, Irvin	CA 7-2349	768 Stewart Ave.	St. P 2

AN OPEN LETTER

to

THE MEMBERS OF THE GEOLOGICAL SOCIETY OF MINNESOTA

The purpose of the Geological Society of Minnesota, to quote from the articles of incorporation, is to promote interest in the study of Geology for its cultural value. The program of the Society consists of a series of lectures given on Tuesday evenings from October through April and field trips during the summer; which trips are the laboratory part of the course. As the Board of Directors arranges a program for the season, it is influenced by suggestions and recommendations from the members.

For a lecture program during the past years the Society has drawn heavily on the members of the Geology Department of Geology at the University. Lectures given by members of the Geology Department are naturally professional in scope and delivery and, of course, make the best program that can be obtained. The staff members of the Department of Geology have a full schedule of work at school besides their interests and work. The Society cannot always depend on securing such professional help for all its programs because there is a load limit that the staff can take on and then the Society must go farther afield to make up its programs.

One source of lecturers must be from the members themselves. Those who have attended the programs for any length of time and have a reasonable ability for exposition should offer to take part in the program. The value and success of the educational program offered to members should be reflected in the amount of information they derive from lectures and field trips. There are two reasons for attending any exposition of science or art; one is to be entertained and the other to learn something. Those who have traveled and observed geologic structures about the country (or any part of the world for that matter) and have, perhaps, taken pictures that can be projected on a screen, can add considerably to the possibilities of program material. Those who are interested in field trips and wish to help as leaders can obtain information and direction to sources of information by members who have conducted field trips in the past.

We cannot always depend on enough professional help for a complete program and must begin to draw for program material from the membership. Anyone who has some material useful in the lecture series or on field trips, please give your name, address and telephone number to any member of the Board of Directors, whose names are listed on the first page of this bulletin. You can also be assured of help by older members of the Society.

THE BOARD OF DIRECTORS,

GEOLOGICAL SOCIETY OF MINNESOTA.

TIME

by Edward H. Mandell, M. D.

In all scientific investigations, one factor always crops up which defies analysis. That factor is time. What is time? What is its composition, if it has composition? What is its motion or speed, if it has motion or speed? Where is it? Whither does it go and whence does it come? Can it change tempo or direction? These and other questions about time elude scientific answer.

Man, the scientist, in his insatiable urge to fathom life's mysteries, has constantly sought to reduce the universe to its elementals. He tries to discover and explain the nature of the forces about him. He seeks after truth; and truth, to him, is an understanding of the natural and universal laws. He studies the substance of the universe and tries to reduce it to its simplest terms and to measure the qualities that give each its individuality. He must know the forces they create and what force acts upon or within all things. To do this, science is ever alert to devise finer instruments of measurement, probes for peering deeper and newer and more complex mathematical formula to explain what he already has learned and to chart the course to knowlege not yet learned. In all of the scientist's investigation, either in the laboratory or in his mathematical deliberations, all things are accepted as objectively real - having existence outside himself. He becomes aware of these things through perceptive senations from without. This is true of everything but time. Man has no sense organ to feel time. He only knows it exists by some inner awareness. He cannot prove its existence but his consciousness makes him certain; and our scientist insists therefore it must exist. Not only is he certain of its being but all his reason gives it motion and direction - not in space to be sure but in time. Here we come to our first peculiarity of time, that it moves within itself with apparently no reference to any other frame of observation. This much we seem to get from some inner revelations.

Why can we not investigate time objectively? We can see and feel a stone; we can weigh it in a balance; we can determine its mass; we can analyze its chemical components. We can determine where it lies or its relative position in space. We can throw it and measure its velocity, its direction, its acceleration and deceleration, and even explain its gravitational fall to earth. If it were made of iron we can calculate the electricity generated as it passed through the earth's magnetic field for we know that the atom iron possesses properties of magnetism and we have learned many of the laws that govern this force.

Whatever course the investigation of our stone takes, the factor of time must be a part of our calculations; the time its crystals needed to be formed under a set of circumstances; the time of its flight when thrown; the time of its fall. And this time we cannot perceive and can but crudely measure.

Our language is full of reference to time. "Time drags." "Time flies." "Time stands still." "Time passes." These are but a few. Where do we get these peculiar notions of time? The scientist can exert no force to act on time, no chemistry to alalyze or syenthesize it. The laws of physics do not affect it; it is not changed by heat or slowed by cold. It has no mass and bears no relationship to quantity or units. Magnetism and radiation do not affect it. No physicist has dared to propound a wave or mechanical theory of motion to it. All we can say is that time is, is entire and indivisible and must be from the beginning to end.

Time is used as a measure in many places and under many conditions. But how can we measure time? Clocks are but crude measurements of the speed of the earth's rotation and calendars but crude measurements of the speed in our orbit around the sun. These are an estimation of time from speed and distance factors. Is time then a coefficient of motion and distance? Motion and distance are relative factors having reality only in a given plane of reference. Time seems absolute. In our present knowlege, it is to the speed of light that we ascribe an absolute value. Is the speed of light then the measure of time? Again, radioactive substances disintegrate at a fixed rate albeit that this disintegration is by a series of jerks rather than a smooth even process. The rate of break-down is fixed and constant. It is affected neither by physical or chemical consideration.

Time alone is the measure of this break-down rate. May we not use the break-down as a measure of time? In some fields of scientific investigation, we do just that; as the modern geologist does in measuring the age of certain rocks. Even in this last sentence we introduced another concept. Is age a quality of time?

We have spent some time now discussing the measurement of a factor known as time; but have we come any nearer to an understanding of what it is? Our consiciousness tells us that time passes or moves, but even more than that, it has a fixed direction. Yesterday came before today and tomorrow must follow. It is inconceivable that the reverse can be true. Scientific calculations, however, do not give to time a fixed directional flow. All the equations conclude it should go forward or backward. Even this concept, of forward and backward, allows for movement in only one plane. Since we do not know anything of time we really cannot decide whether its movement cannot also exist in two, three or even ten dimensions.

All reason objects to any backward flow of time. The scientist, who is usually a reasonable creature, has injected the time symbol (-1) - the square root of minus one - into all his equations to give time a constant forward direction. Yet all sciences, except biology, would indicate that time is reversible. This idea is obnoxious to the biologist. Scientists being biological animals have also found an uncertain direction in time, offensive. They arbitrarily give it positive direction. Albert Einstein, in the evolution of his Theory of Relativity uses time as a fourth dimension. If time is thus a dimension, then it can have no direction of motion. Planck showed as one of the conclusions of his Quantum Theory, that nature apparently proceeds by a series of jerks. Our impression of time is that it flows smoothly. It is probable that our perception of time is faulty.

We do not see the continuity in time. We see rather as a series of jerks. We see like a motion picture camera - picking up a series of instantaneous nows. We do not see the past or future. We can get some idea of what vision in time would be like from viewing the streaks over a photographic plate exposed for a long period in view of a moving object. Such a picture, taken at night, of the headlights of moving cars appears as a pattern of white swirling streaks. Thus, if we could view someone in time's fullness, that person would appear as a long undulating worm, small at the birth end, swelling through maturity and shrinking away in death.

Man does not possess such a vision but he can grasp such an idea. In the study of our universe, an all inclusive concept must be hypothecated. Such a vision must be owned by whatever God there be, as part of his powers. I would not be so presumptive as to define or limit these powers. I would not dare to limit Him to my vision or my image. In contemplation of the universe, it is evident that it is still in the making. Dare we relegate that Power to dotage by an implication that He finished His work and purpose, and now sits back, drowsily contemplating this thing already wrought. On the contrary, we must assume that God is still busily engaged in the completion of His experiments.

In the final analysis, time, to us, is the change in the relationships of the various components of the universe in relation to each other. They are ever being more thoroughly mixed, moving to what the physicist calls Entrophy. When all the parts shall be so thoroughly mixed, that any further mixing can no longer change their relationship, time will cease and the experiment be completed, or perhaps have come to full circle, to be started anew.

Reprinted from a 1950 issue of THE MINNESOTA GEOLOGIST

SOILS AND SOIL MINERALS

By James O. Montague

Honorary Curator of Geology Milwaukee Public Museum

When we really understand soils; learn how they originated; know their composition; realize what they mean to humanity and that all mankind as well as all other vertabrate creatures came from them and will return to them when their life cycle is completed; all of us will become true conservationists. When we speak of soil we do not usually associate it with rock, but nevertheless, all igneous, sedimentary, and metamorphic rocks are the beginning of soils. It is by the disintegration of the parent rock into clay that soil is formed. However, there must be a physical break down and chemical changes must take place before this can happen.

Continents were made when vast areas of land emerged from the sea bringing to light the sedimentation of millions of years, and mountain ranges thrust their lofty peaks high into the air in majestic grandure. We speak of the eternal hills or the abiding plains, not caring or being ignorant of the fact that nature's destructive forces started their work as soon as the emergence appeared above water.

A rocks ability to absorb the suns heat and expand during the day and to contract in the nights cold opens the door for its destruction. This expansion and contraction caused small cracks to appear which held the moisture from dew and rain Assisted by the growth of moss and lichens an exfoliation or peeling off of the surface began. When frost came, freezing the crevice held water into ice thereby deepening and widening the crack by its tremendous pressure, erosion really started. The continued process of heat and cold, freezing and thawing, separated great chunks from the parent rock which fell down the mountain slopes as talus. The same destructive forces continued their work on the talus piles. The rains washed the fine particles onto the plains or they were carried farther away by wind or stream action. Trees also assisted these erosive forces by thrusting their roots deeply into the rock crevices. The root growth pressure being great enough to assist in breaking off rock fragments. Soil of this character is known as rock rot.

When climatic changes became so pronounced that the cold and snow of winter exceeded the warmth and rain of summer, the great ice sheet that covered a goodly portion of the North American Continent came into being. In its southward movement, it tore loose from the parent rock untold millions of tons of boulders and transported them far to the south. As the thickness of the glacier increased, its erosive and grinding power became so powerful that much of the rock load was reduced to a rock flour. When the glacier receded, this material, along with the rock, gravel and sand within was deposited as residual clay, the basis of soil.

The chemical changes necessary before the parent rock could be transformed into soil was the hydration of the feldspars, and the oxidation of iron and the solution and carbonization of soluble bases.

These forces all worked in unison. A full explanation of their action will take more time than we have to spare in this talk. However, all rocks containing iron readily decay when oxidation takes place.

The residual clays, either as rock rot or rock flour, containing the mineral elements composing the parent rock, did not make productive soil. When dry, the contraction was so great that large cracks were produced which allowed the surface air to circulate too freely through them. When wet, the expansion was so great that both air and water were prevented from entering the soil. Consequently, these clays would not support a high degree of vegetation although they contained the mineral elements so necessary to promote plant growth. The thing needed to create a productive soil was humus.

Humus is not incorporated into a soil in a day month or year, but is a long drawn out process of centuries. After producing the residual clays, nature began its work of creating top soil by the process of life and death. To illustrate: the lowest forms of life such as moss and lichens appeared and through their feeble root systems extracted some of the nutritional mineral elements from the clay before dying. This process was repeatedly carried on until enough organic matter was mixed with the clay to form the top soil able to support a higher type of vegetation. This process continued until finally tall grasses dominated the scene on the great plains and stately trees ruled the wooded areas. Nature wasted nothing but returned everything to the soil with interest added.

The process of decay through bacterial action that began with the advent of moss and lichens increased as vegetation advanced. The putrefactive bacteria that attacked the dead organic matter, whether it was leaf or tree, broke down the cell structure and opened the way for its return to the soil as humus. Immediately the soil bacteria began its work of further breaking down the organic residue and releasing the mineral elements for use again. It was through this process, repeated over and over, that humus was incorporated with the clay and top soil created. Humus imparts either dark or black color to soil. Muck soil is composed mostly of decayed organic material. On upland soil it required hundreds of years to place one inch of humus in the top soil. Six to eight inches is the average depth of top soil that is farmed so intensely to produce the worlds food supply. Civilization is placing a heavy burden on the top eight inch shell of old Terra Firma.

Soil mineral elements were released for plant consumption when the parent rock had been completely disintegrated and chemically changed so plants could feed upon them. By the chemical analysis of organic matter a number of elements have been found that are necessary for plant growth. However, our discussion will deal with eleven that have proven to be absolutely essentail ... they are; nitrogen, phosphorus, calcium, magnesium, manganese, copper, iron, sulphur, boron, potassium and zinc.

Nitrogen, being a gaseous element and composing about four fifths of the earths atmosphere, is not found in the soil forming rocks. Plants obtain it as a food entirely from the soil. Through the process of decay and putrefactive bacteria breaking down organic substances such as dead plants, manures and all other dead organic matter, nitrogen is added to soils. It is also added to soils by bacteria, some living independently of higher plants and others in the root nodules of legumes such as clover, alfalfa, soybeans, cowpeas, lespedeza and others. Some enters the soil with rain in the form of a weak ammonium nitrate. It increases growth above ground and is a very important element which is consumed rapidly by modern farming methods. Unless supplemented by manures, legumes and nitrogenous fertilizers it is rapidly depleted.

Nitrogen is a constituent of all plant and animal organisms and of many important compounds but cannot of itself support animal life. It is the distinguishing element of the proteins, and necessary in the formation of protoplasm, chlorophyl and other plant compounds. Nitrogen stimulates plant growth by imparting a dark green color to leaf and blade when present in sufficient amount.

Plants indicate very quickly whether they have an excess or deficiency of nitrogen. If an excess, leaves become unusually broad and dark green, the internodes in stalks grow exceptionally long and the blades extra long and soft. The stalk falls over and is too weak to raise itself erect. This is at the expense of fruit and grain. Nitrogen deficiency is first noticed by a discoloration of leaves and blade which become light green and yellow with a retarded plant growth reducing grain and fruit yields.

Phosphorus in soils is dreived mainly from the mineral Apatite and works below and above ground in plant development. It is a root developer producing stronger roots, particularly the fibrous rootlets through which all nourishment taken from the soil must pass into the plant. It decreases the ratio of straw to grain by hastening the filling of the grain and an earlier maturity. Due to its balancing effect on nitrogen, straw is strengthened. It improves the quality of crops as well as increasing the percentage of phosphate in cereal grains. Plants are more disease resistant when fed sufficient phosphorus. It helps form many protein substances, divides cells, and is a constitutent of nearly every living plant cell. Phosphate deficiency is first noticed in a discoloration of leaves which become reddish purple.

Phosphorus is an absolutely essential element in building inorganic bone structure which is composed of phosphate, carbonate of lime and carbonate of magnesia. Phosphorus has an affinity for calcium, iron and alumina and is most readily available as plant food when the pH soil value is neutral. When the soil is too alkaline, phosphorus combines with calcium as calcium phosphate and greatly lowers its availability as plant food. On the other hand, when the soil is too acid, it combines with iron as iron phosphate, or with alumina as aluminum phosphate, which markedly reduces its value as plant food.

Nature has been very liberal with phosphate deposits in many countries of the world. North America has immense supplies in Florida, Georgia, Tennessee, Montana and Canada, estimated to last for over 2000 years. This is in the form of calcium-phosphate and must be acidulated with sulphuric acid to release the phosphorus quickly available for plant use. However, it can be applied to the soil in the form of ground rock phosphate. The release is so very slow that exceptionally large quantities must be spread to supply the plants needs.

Potassium, the third major plant food element in soils, is derived from the minerals orthoclase feldspar, muscovite and biotite mica, and the zeolites. For a number of years soil specialists paid very little attention to this soil element. Cabbage, cauliflower, tomatoes, melons, pickles, corn, wheat, oats, rye and barley consume liberal amounts. All flowering bulbs, roses, hydrangea and other woody plants require heavy feeding to assure proper development.

Potassium supplies sugars and starches and furnishes the fiber and rigidity of stalks and stem. Root crops such as potatoes, sugar beets, beets, turnips, onions, carrots and swedes are heavy feeders on this element. Cabbage, cauliflower, tomatoes, melons, pickles, corn, wheat, oats, rye and barley consume liberal amounts. All flowering bulbs, roses, hydrangea and other woody plants require heavy feeding to assure proper development.

Potassium is a necessary component of chlorophyl and is essential in coloring bloom.

Its deficiency is readily discernable in corn by a yellow streak on marginal fired leaves, short internodes and poorly developed ear, the end of the cob being grainless. White spots on leaves of alfalfa, red and alsike clover are due to potassium deficiency.

Up to World War I, Germany produced practically all of the worlds supply of potash. The United States was in a precarious position when the German shipments stopped. Luckily for our country, the war did not last long enough to greatly reduce the natural supply in the soil. This condition revealed one great weakness in our economic system. Immediately, both private enterprise and government laid plans to correct the situation. The vast potash deposits of sylvanite around Carlsbad, New Mexico, and in other sections of the southwest were discovered and mining operations started. A successful method of separating potash from borax in Death Valley was discovered and put to work. At the present time the known potash deposits in the United States are large enough to supply our needs for several hundred years. All indications point to the finding of more deposits. We should be thankful for one thing. Our government encouraged private capital to develop this industry.

Calcium is a very important soil element and performs a number of useful functions in plant growth. All plant structure contains a certain amount of it. Soil acids are neutralized either by the calcium content of the soil or by applying a sufficient amount to bring about this neutralization. Calcium increases the number and vigor of nitrogen fixing bacteria, both those living independently of higher plant life and those living in the nodules of legumes. Alfalfa, clover, sweet clover, lespedeza, soybeans, cowpeas and all other nitrogen fixing plants require a neutral or alkaline soil for maximum growth.

Calcium is a very necessary element in milk and other foods consumed by both humans and animals on account of its bone building qualities. Combined with phosphorus in the proper proportions, a healthy bone growth is assured. It is very essential to carbohydrate and protein metabolism of plants. A deficiency is apparent by yellowing of leaves and a general loss of strength in plant structure. The natural calcium in soils is derived from calcite and dolomite, which are carbonates, and from gypsum which is a sulphate. Ground dolomite is usually used as a soil conditioner and a rectifier because of its magnesium content. When a soil becomes excessively alkaline, applications of gypsum will rectify such condition.

Natural soil magnesium is derived mostly from the minerals horneblende, augite, biotite mica, serpentine, chlorite, dolomite and talc. While its function is not completely understood, it is an evident fact that plants require it in a greater or lesser degree to grow properly. It is associated with calcium in the cells of practically all plants. Its absence results in the failure of fruit to mature.

Magnesium is absolutely necessary in the structure and flow of chlorophyl in all plants. Donald Culross Peattie, discussing chlorophyl in his book "Flowering Earth", notes the close resemblance of chlorophyl to hemoglobin, the essence of blood. The significant difference in the two structural formulas is this; that the hub of every hemoglobin molecule is one atom of iron, while in chlorophyl it is one atom of magnesium.

When the soil is deficient in this element it can be remedied by the application of pulverized dolomite. Where some particular crop may require an extra amount it can be very readily supplied by mixing magnesium sulphate with fertilizer.

Manganese has been studied for a number of years as a soil element needed in plant growth. There are at least twenty four minerals that contain manganese, included in this number are pyrolusite, psilomelane, braunite, wad, manganite, rhodocrocite and franklinite.

Some iron ore deposits contain manganese, particularly the hematite from Hurley, Wisconsin and vicinity which runs as high as 14%. This ore is in great demand in the manufacture of manganese steel. It is not so evenly distributed in soils as some of the other elements.

In 1872 M. A. LeClere made a study of manganese in soils and found it as a constituent of the dry weight of all plants analyzed, occurring in root, stem and fruit.

It is almost impossible to grow a crop on highly alkaline soils without manganese as a soil nutrient. This was definitely proven on the calcerous soils of Flor... which would not produce until experimentation proved that manganese was the missing element needed for successful production. Citrus trees that failed to bear or produced just a few fruit, became heavy bearers when fed a sufficient amount of manganese sulphate. Truck crops, such as tomatoes, potatoes, cabbage, cauliflower, carrots, beets, cucumbers and melons became very profitable when this element was used in a fertilizer mixture. The same thing is true with calcerous muck soils of Michigan.

Manangese is essential in the flow of cholorphyl. Its largest concentration occurs in the leaves and the pericarp and germs of seed plants. A manganese chlorosis appears on the leaves of many plants when this element is lacking.

In animals the liver, kidney and pancreas are the richest and the muscles are the poorest in manganese content. It is a necessary ingredient in poultry feed as it overcomes the disease of slipped tendons or Perosis in all types of fowl. From all data at hand the presence of available manganese is absolutely essential to the growth and health of all forms of plant and animal life.

Copper was not recognized as a plant food element until the beginning of the twentieth century. Many states have conducted experiments and have proven its need in plant growth. Muck soils contain very little if any copper. It is beneficial in increasing the chlorophyl content of crops. It improves the color and thickness of onion husks. It increases the general health of plants. It colors carrots an orange yellow. Lettuce, onions and spinach are improved and show a marked difference in flavor when fed copper sulphate.

Tissues of the brain, kidneys, liver and heart contain the most copper in humans and animals; while the skin, lungs, pancreas, spleen and flesh contain the least. Copper plays an important part in the production of all protoplasm as is indicated by its presence in all plants and animals.

Iron is a constituent element of many minerals and is present in all igneous rocks, also secondarily in the sedimentary and metamorphic rocks. It composes about 5% of the earths crust. Being so universally distributed in all types of rock the resultant and residual clays contain a good percentage of iron.

Iron is responsible for the color in clay soils. If the color is yellow, limonite is the dominating mineral; if it is red, hematite predominates. The addition of organic matter will change the top soil color in proportion to its fixation as humus may take place. When enough organic matter has been added to create a muck soil, black predominates as a soil color. The color of the underlying subsoil should tell its derivitive source.

As far back in the distant past as bacterial life can be traced, iron was the one element found to be present and continued to function in all forms of plant and animal life up to the present time. Without it life could not exist.

Many plants are rich in iron, particularly spinach, which is recommended as food for its iron content. It is one of the elements that assists in the flow of chlorophyl, a deficiency causes the leaves to turn white. Iron is absolutely essential in all animal life, including humans. Without it the formation of hemoglobin in the blood could not take place. It is estimated that there is enough iron in the human body to make an eight penny nail.

Sulphur in its natural elemental form is widely distributed and is also a constituient element in many minerals such as gypsum, galena, sphalerite, pyrite, marcasite, chalcopyrite and a host of others. It has been recognized since 1804 as a plant food element. Nature has been very generous in supplying soils with this element. It not only functions as a fertilizer ingredient but plays an important part as an insecticide and germicide.

Sulphur improves the structure or physical condition of soils by bringing lime into solution and making them more drouth resistant.

It is an absolute requirement of plants and all other organisms. It is a constituent of protoplasm and of many proteins. A sulphur deficiency causes a cessation of plant growth and the untimely death of the plant. It is required and widely distributed in animal proteins, tissues and fluids. Wool and hoof contain 3% to 5% of sulphur.

A Miss Beachley, working in the laboratory of the Rothemstead Experiment Station of England, the oldest agricultural research institution in the world, reported in 1906 that boron is an essential plant food element. This was confirmed in 1910 by Agulhan, a French investigator. It is a constituient element in the minerals, borax, datolite, dumorterite, kernite, tourmaline and others. Experiments conducted in England, Canada, and the United States and other countries during the past thirty years have enlightened the soil specialists on its need as a plant food element and a rectifier of plant ills. Commercial borax is the form used in agricultural fertilizers.

In the decade between 1920 and 1930, in the rural sections of the United States and Canada, it was apparent that certain crop diseases were not controlled by commercial fertilizer applications. The discovery was made that this was due to a boron deficiency in the soil.

In apples, drouth spot, corky core, apple measles, rosette and dieback, and in pears drouth spot, were due to a boron deficiency. These diseases were overcome when a proper amount of this element was applied. The same thing was found to be true in the heart rot of sugar beets, white core of turnips, yellow top of alfalfa, cracked stem of celery, browned leaf condition around the curd and the curd may be of a brown appearance in cauliflower, and the internal black spot in table beets were all due to a boron deficiency. Tomatoes, carrots, potatoes and strawberries reacted favorably when treated with a small amount of borax.

Zinc has only been considered a plant food element in recent years. A comparatively large number of minerals contain zinc as a constituient element. Zincite, willemite and franklinite are the zinc ores mined extensively at Franklin, New Jersey. Willemite is the only one found outside the Franklin area. Of the other zinc minerals, in all probability sphalerite is the most widely distributed and may be the source of much of the zinc found in soil. It is found in the sedimentary rocks and is associated with galena and fluorite. It is a common mineral in the leaf fossils of the Illinois coal fields. Just how and in what manner it functions in plants is not fully understood.

The Florida Experiment Station has carried on extensive experiments with zinc as a plant food element and have had some excellent results on corn, oats and cowpeas. Velvet bean production was improved when followed on ground treated with zinc sulphate for corn. Zinc sulphate applied to peach trees overcame the disease known as "Little Leaf" and to tung trees the disease known as "Bronzing".

It has been definitely established that zinc is essential to the growth of higher plants. Deciduous trees need it for proper growth and development. By using zinc sulphate on pecan trees, the Alabama and Georgia growers overcame the Rosette disease and saved their trees from destruction.

Society owes much to the pioneer soil scientist. Through experimentation with crude laboratory equipment and a system of checks and balances, they were able to lay the foundation for a profitable agriculture. Now, with modern laboratory equipment and a highly trained field service, new discoveries are made each year. Elements such as iodine, cobalt, molybdenum, fluorine and others are known to be absorbed by plants and to be found in both animals and humans. To date the requirement of plants for these elements is so small that it is almost impossible to supply it. Our faith in our soil scientists is great enough to believe that they will soon be able to determine the amount to be added to the soil or water for human consumption.

One thing should be thoroughly understood; plant food elements work in unison on all plant growth when the soil is supplied with them, either in the original soil structure or added as fertilizer. It is the absence of one or more of these elements that becomes apparent in plant growth. Plants quickly show their ailments and the grower is a wizard when he can detect every ill. The professional soil specialist is very often baffled by the plants appearance as so many things enter into growth picture. The soil must be properly prepared for seeding; the pH value must be right for the crop to be grown; there must be sufficient cultivation to kill weeds and conserve moisture; there must be a proper fertilization with a balanced plant food; the rainfall must be enough to supply the needed moisture; the temperature must be even enough to assure the desired growth, and the season be long enough to insure the proper plant, fruit, and seed maturity. Unfortunately, these conditions very seldom prevail. It is either too dry or too wet, too cold or too hot; the season too early or too late for proper growing. These conditions are not just complaints, but actual happenings at times. The grower is very wise, indeed, when working against these natural conditions, if he can detect all the plant food deficiencies that may arise. However, extreme conditions are not the rule but more often the exception, and the farmer can maintain a fairly even crop production over a period of years.

Due to economic conditions, a great majority of people have left the farm to become city dwellers, yet mother has one or more potted plants growing on the window sill, and father cultivates a vegetable or flower garden in the back yard. It all adds up to this; they may have left the farm but plant husbandry is still in the blood.

Urban dwellers should be keenly interested in the fruits and vegetables they buy, because within them is either found or lacking the mineral elements so necessary for proper body development and energy. They tell their own story. Fully developed apples with plenty of color; grapefruit that are thin skinned and heavy in weight; onions with thick husk and small stem end; cucumbers fully developed from stem to blossom end; corn even rowed and well filled to the end of cob; a dark green colored spinach with no tip burn on edge of leaf; carrots dark orange in color; all tell the story that they have had sufficient plant food elements to properly develop and mature them as valuable food.

It pays to be choosy when buying both fruit and vegetables. The dealer may resent the picking over by his customers, but when he realizes that he may have his profits tied up in undesirable merchandise, he will purchase the best when he goes to market. Our mineralogy can become very valuable to us when we make use of it in purchasing food.

We have become vitamin conscious as a nation. Newspapers, magazines and radio allot liberal space and time to the discussion of their beneficial effects upon the human body. Assuming that they are insufficient or lacking in our food, we are urged to purchase this or that vitamin pill to supply our body requirements.

A vitamin is a substance of unknown components essential to the diet of man and inferior animals. The lack of these minute constituents of food stuffs produces certain morbid conditions. B1, B2 and C, the water soluble vitamins found in egg yolk, fish roe, yeast and fresh vegetables prevent beri-beri, pellagre and scurvy. The fat soluble vitamins A, D, and E, found in milk, butter, animal fat, and cod liver oil, cure and prevent xeropthalmia, an eye disorder, and rickets caused by insufficient calcification of bones, and promote fertility. Vitamins are exceedingly important in mans nourishment at all stages of life.

The soil elements which we have been discussing are responsible for the vitamins in food. When any of these elements are lacking, the food produced from such soil is minus certain vitamins and is not a real healthy food. One of two things has happened; these elements were lacking in either the soil building or were depleted by intensive cropping and were not replaced. A condition of this kind could have been excused fifty or seventy five years ago, through ignorance, but not today. All intelligent farmers realize it would be inexcusable in present day methods of farming. There is only one remedy, proper fertilization.

The fertilizer industry has been growing by leaps and bounds during the past fifty years. This one instance alone will prove the point. The fertilizer usage in the state of Wisconsin in 1927 was, in round numbers, 22,000 tons. In 1951 it was over 400,000 tons. The potential usage in Wisconsin is over 1,000,000 tons annually, and this is only one of the 48 states and territories. The Agricultural Colleges, Experiment Stations, Fertilizer Manufacturers, and Farmers are striving to return the depleted mineral elements to the soil, and to maintain the natural supply in the soils. The American farmer has met every challenge made to him for increased food production in times of emergency. Our country has no need to worry over its food supply. We are the best fed people in the world and will continue to be. The farmer is doing his best to furnish all the necessary mineral elements in his crops so that the consumer will be able to purchase them and the attendant vitamins on the market, which will eliminate the need of securing a pill box.

MEMORIAL
to
CHARLES H. PRESTON.

Prepared by Loretta E. Koppen.

Charles H. Preston was born near Puckaway Lake, Green Lake County, Wisconsin, in April 1876. He died in Phoenix Arizona on June 14, 1955. Both his father and his mother were of very old New England ancestry. His mother was Elizabeth Dewey, who was a direct descendent of Governor Bradford of Plymouth Colony.

Mr. Preston attended the local grade and high school of the county of his birth and then took a complete course in Business Administration at the University of Wisconsin, graduating in 1906. Following graduation, he taught business subjects in high schools of Aurora Ill., and Oshkosh, Milwaukee and Superior Wisconsin.

He came to Minneapolis in 1910 to accept a position on the faculty with the Economic Department of the University of Minnesota. He later arranged the Extension Division courses on business subjects, particularly accounting and business law, and for five years was in charge of the Extension work in these subjects.

In 1918 he opened his own office for the practice of Accountancy and in 1920 became a certified public accountant. He continued however, to maintain his interest in the Extension Division work at the University and to teach accounting and income tax until 1938. In connection with his professional work he built a well-rounded organization. For more than 20 years he was Tax Consultant for the Minnesota Bankers Association, serving over 250 banks throughout the State. In 1926-27 he was President of the Minnesota Society of Certified Accountants. He was also a member of the Rotary Club.

In 1902 he married Ruth Pierce who was also a resident of Green Lake County Wisconsin. Mrs. Preston preceded her husband in death in 1947. Mr. Preston is survived by two daughters, Katharine Bradway of California and Lucille Preston of Phoenix Arizona.

In 1938 Mr. Preston noticed an article in the paper authored by Mr. Edward P. Burch, founder of the Geological Society of Minnesota, announcing the organization of a group to study Geology. Mr. Preston attended the meeting and ever since that time he maintained a deep and abiding interest in Geology.

Shortly after joining the Geological Society of Minnesota Mr. Preston was elected Director and Secretary of the Society. He was an active member of the Board from 1938 to 1951. He originated the two week summer field trip idea for the Society members and he arranged, planned, and lead field trips to the Grand Canyon, The Black Hills of South Dakota, Yellowstone National Park, Estes Park etc.

Mr. Preston was instrumental in having the Geological Society of Minnesota join the Midwest Federation in 1945. He was elected President of the Federation in 1950 and served on numerous committees from time to time. He was also active in American Federation of Mineralogical Society work. It was through his untiring efforts and enthusiasm that the American Federation has made available the car emblems for members of all affiliated Societies of the Regional Federations.

This memorial is made as a permanent record of our respect and regard for Mr. Preston and of his faithful devotion to the Geological Society of Minnesota, the Midwest Federation of Mineralogical and Geological Societies, the American Federation of Mineralogical Societies and the general welfare of these organizations, as well as his love of the subject of Geology for its cultural value.

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