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Vol. 120. No.5
Printed in U.S.A.

IN RECOGNITION OF MARION L. JACKSON ON THE OCCASION OF HIS SIXTY-FIRST BIRTHDAY, NOVEMBER 30,1975

On July 1, 1974, Marion Leroy Jackson was awarded the Franklin H. King Professorship of Soil Science at the University of' Wisconsin at Madison. Letters supporting his nomination to this award came from dozens of scientists from around the world, which characterized him as a truly eminent scholar, a great educator, a man of vision, scientific integrity, extraordinary leadership, and boundless energy. A professor of soil physics went so far as to say that he regarded Dr. Jackson as "having the greatest total knowledge of soils, in breadth and depth, of any living soil scientist." His accomplishments in the service of science are truly prodigious. Now, on the occasion of his sixty-first birthday, we may well consider his career which is currently at full height. A review of his findings will help us to appreciate the powerful thrust of his life work and the nature of the environment that has fostered his endeavors.

Marion L. Jackson was born on November 30, 1914 on a farm near Reynolds in Jefferson County, Nebraska. He was highest ranking scholar and valedictorian in the class of 1932 at the York, Nebraska High School. He received the gold medal for highest ranking scholarship each of his four years at the University of Nebraska, where he was conferred the "B.S. degree with High Distinction" in 1936, and the M.S. degree in soil science in 1937. He worked for a year as Land Classification Aide, USDA Resettlement Administration headquartered in Lincoln, Nebraska, with field work in northwestern South Dakota, before going to the University of Wisconsin (Madison) where he completed the Ph.D degree in 1939. He served as a postdoctoral fellow in the Department of Soil Science, University of Wisconsin, 1939-41; instructor, 1941-42; assistant professor, 1942-45; associate professor. 1946-1950; professor of soil science, 1950-1974; and Franklin Hiram King Professor of Soil Science 1974- . He was on leave to serve as soil chemist and associate professor in the Department of Agronomy at Purdue University, December, 1945 to June, 1946: visiting professor, Department of Agronomy, Cornell University, February 8 to March 20, 1959; and distinguished visiting professor, College of Forest Resources and Quaternary Research Center, University of Washington, Seattle, March 27 to June 8, 1973. He filled more than 20 other lectureships, of which seven were in foreign countries. He is a most lucid and stimulating lecturer who makes full use of the important impact of visual aids, giving as much thought to oral and illustrated presentation as to written communication.

During his 33 extremely productive years on the faculty of the University of Wisconsin, Dr. Jackson has served as major advisor and extraordinary research director for 57 graduate students working for the Ph.D degree and 30 scientists on postdoctoral and sabbatical programs. These workers were from many locations in the U.S.A. and many foreign countries. He has authored and coauthored more than 180 publications, of which two are major textbooks, entitled, *Soil Chemical Analysis* and *Soil Chemical Analysis-Advanced Course.* These books have been translated into several foreign languages, including Spanish and Russian. He is author or coauthor of individual chapters and sections in more than a dozen books, symposia, and encyclopedias. The quality of his work has grown concurrently with an ever-increasing breadth of both basic thought and important applications in agriculture and industry.

Dr. Jackson has few peers in the areas of his professional interests, which include quantitative determination of soil mineralogy, silicate crystal chemistry, the geochemistry of transformation of minerals by weathering processes, the retention by soil minerals of radioactive isotopes that may be mobilized by nuclear fuel processing, and the oxygen isotopic ratios of silicates by which the provenance of silts in sediments and soils can be traced through glacial, fluvial, and eolian transport. He has devoted time and energy not only to basic, principle-oriented research, but also to immediate and practical application of his findings. He and his students have investigated the causes and correction of soil acidity and its seat in aquoaluminurn ion monomers and polymers; phosphate fixation, release and analytical chemical fractionation in soil systems; and influence of clay mineral species on movement and retention of pesticides and herbicides in soils. The importance of his contributions world-wide to soil and earth sciences can hardly be overestimated.

One of his major early contributions was the concept of a weathering stability sequence of clay-sized minerals in soils. This concept unified earlier considerations of weathering processes as fragmented systems under various climates, vegetations, and geomorphic sites. His later work showed that the climate, vegetation, and geomorphic site determine the solute composition of the soil matrix solution, rather than an equilibrium with the minerals present in the soil. The solute composition of the site then determines the minerals forming or formed authigenically in the site, in accordance with

thermodynamic mineral stability diagrams. Dr. Jackson's unifying concepts of soil weathering processes have received world-wide attention, and have been incorporated into modern soil classification and principles of pedogenic research.

While developing the weathering stability sequence, he and his students were investigating related problems that included release of potassium, aluminum, and other ions during weathering, and their influence on availability of plant nutrients, soil pH and cation exchange capacities. The wedge-configuration formed by crystal layers at the lateral boundaries of vermiculite and mica (in the XY cleavage planes) was presented in his lectures of the late 1950s as the site of fixation and release of the plant nutrients, potassium, and ammonium, and later published in 1963. His comments, at the Soil Science Society's 25th anniversary celebration on the occasion of Hans Jenny's lecture on "The Soil Acidity Merry-Go-Round," recounting an unresolved vacillation between hydrogen ion and monomeric (Al^{3+}) aluminum as the seat of soil acidity, won Dr. Jackson an invitation from President-elect Dr. C. A. Black to address the Soil Science Society on the subject at the next meeting in the summer of 1962. There he presented the unified theory of soil acidity which showed that exchangeable $Al(OH_2)^{3+}_6$ *is in fact* a proton (hydrogen) donor and the seat of active soil acidity with a pK value of about 5, thus conforming to Dr. Richard Bradfield's earlier (1923) position that acid soil was H-soil with pK about like acetic acid (pK, 4.7). The Al-to-H-to-Al "vacillation" for over 60 years disappeared. After the lecture Dr. Bradfield came to the rostrum and declared "I knew there was a proton donor in soil of strength similar to that of acetic acid. Now you have deduced the mechanism that removes the dichotomy with Dr. F. P. Veitch (1904) and Dr. C. E. Marshall (1933) which held that exchangeable Al^{3+} was the seat of the soil acid." The conflicting views became unified!

The presence of polymeric hydroxy aluminum in soils was shown to confer hysteretic pH-dependent charge. Previously, people had said that pH-dependent charge arose at "broken edges of clay," but Dr. Jackson and his associates showed that positively charged hydroxy aluminum, which neutralized the *permanent* negative charge of the clay layers, gradually lost its positive charge progressively (deprotonated) with rise in pH with liming, thus activating the "latent acidity" the source of which had long been a puzzle.

Analytical methods developed in his laboratory for fractionation and determination of different forms of soil phosphorus are used throughout the world as standard references. The full spectrum of phosphates is considered, from calcium to iron and aluminum phosphates and iron-oxide-occluded forms. An important finding was that liming, through changing the soil pH, increased phosphate availability by lowering the iron and aluminum activity, and not, as previously thought, by conversion of the phosphate to a calcium phosphate form.

Less well known is some of Dr. Jackson's work on soil fertility done during the early part of his career. Because of the importance of' this to agriculture in Wisconsin, two items will be mentioned here.

During the early 1940s he carried out fertility investigations on problems of soils of central Wisconsin. Liming soils by farmers had become largely ineffective. Alfalfa failed with ordinary fertilization. Combinations of liming with high rates of fertilization with phosphate and potassium, in experiments that he established in Clark County, gave spectacular synergistic responses. These results and those in the region by Professor Osborne J. Attoe gave impetus to the program of the College of Agriculture in forage and pasture improvement for the region in the 1950s, which bolstered the dairy industry there.

In the mid and late 1940s, Dr. Jackson carried out some of the first work in Wisconsin with high rates of fertilizer application on corn combined with high stand densities. He realized that with the termination of' the war, nitrogen fertilizers would be inexpensive and abundant, and would play a key role in substantially increasing corn yields, in spite of Wisconsin’s cool, moist weather. His quick response to a scientific challenge is illustrated by the encouragement on his proposal in 1947 received from Professor Emil Truog in the words, "I think you should go ahead with it, since you are young and need the experience, even though I don't think it will work in Wisconsin." Professor Norman Neal (of the Agronomy Department) kindly furnished the seed corn, with the observation, "we've tried higher fertilization without results. We also tried higher stand densities without yield improvement." Professor Jackson and his graduate student Leo E. Orth obtained in 1948 and 1949 replicated corn yields averaging (four replicates) as high as 140 bushels per acre, when essential fertilizer nutrients were appropriately supplied to plant populations of 17,000 per acre. In 1949, when it was apparent in early September that a breakthrough for Wisconsin corn yields had been obtained, Professor Truog mobilized all the department staff and graduate students to go out to see the plots. The work was continued into the 1950s with graduate assistants Lawrence F. Marriott and James A. Kittrick. In the mid 1940s the Wisconsin state average was 44 bushels of corn per acre. It was agreed that the research program would concern itself with yields of over 80 bushels per acre. Professor Clinton J. Chapman was striving to get extension demonstration corn yields up to 80 bushels through the use of 8-8-8 plowed under, with the commonly used stand densities of about 12,000 plants per acre. On the basis of these studies an extremely successful extension program, the "Pacemaker" corn program, was initiated by the Soil Science

Department in 1952 in Wisconsin and in some neighboring states. As a result, the average corn yield in Wisconsin was raised to 90 bushels per acre.

Dr. Jackson's wide interests and keen insights have enabled him to quickly see the interrelationships between phenomena in pedology and related fields. This is best exemplified by his leadership in interdisciplinary investigations of the origin of eolian mineral particles in soils, particularly through the use of oxygen isotopic ratio of the "marker" mineral quartz. This work grew out of his formation of an international consortium for interinstitutional cooperation in the advancement of learning, in cooperation with many universities. Several findings are of particular interest. First is the fact that aerosolic dust consists mainly of quartz, mica, vermiculite, chlorite, calcite, and kaolinite. Second is the fact that ^{137}Cs in the atmosphere and stratosphere from nuclear testing is fixed by the vermiculite, in which carrier it easily moves off surfaces of plants and animals by the rain that brings down the dust. Third, in cooperation with the Universities of Chicago, California, and Hawaii, studies have shown that the quartz and mica of Hawaiian surface soils and Pacific pelagic sediments are mainly of aerosolic origin derived from dusts of and lands of the continents. Fourth, dusts of the Sahara were found to be transported across the tropical Atlantic Ocean to the Caribbean islands and the southeastern part of mainland United States. Fifth, the fine silt of shales, silt-stones, loess, and till were shown to be a composite of quartz from low temperature origin (cherts and overgrowths) with that of high temperature igneous and metamorphic rocks. Lastly, the proportions of this mixture were found to vary from Northern Hemisphere to Southern Hemisphere, as a very distinct reflection of the fact that the Northern Hemisphere continents have traversed across the tropical and equatorial zones during the Post -Precambrian times while the southern parts of the Southern Hemisphere continents have not (known to geophysicists from paleomagnetic studies). In cooperation with the National Center for Atmospheric Research, his research has been concerned with tracing by the oxygen isotopic ratio the world-wide distribution of aerosolic dust which may be important in determining weather phenomena. Dr. Jackson's national and international reputation is evidenced by an impressive number of citations and awards. He is a Fellow of both the American Society of Agronomy and the Mineralogical Society of America. He has served as the president of the Soil Science Society of American and of the Clay Mineral Society. He received the Soil Science Achievement Award of the American Society of Agronomy (the Society's highest scientific award) the second year it was given. In 1974, he was conferred the honorary Doctor of Science degree by the University of Nebraska.

His service to science has been enormous. He has served as review editor for the National Research Council, the *Soil Science Society of America Proceedings, Soil Science, American Mineralogist, Analytical Chemistry, Clays and Clay Minerals, Journal of Geophysical Research, Science, Geoderma, Quaternary Research,* and several other major journals. He has been an Experimental Station review panelist for the USDA, Cooperative Research Service, at the University of Hawaii Agricultural Experiment Station (1966) and at the Cornell University Agricultural Experiment Station (1971). He has served as external examiner of doctoral theses for the University of Queensland, Australia, Punjab University, Calcutta University, University of Delhi, and University of Poona, India. His dedicated accomplishments complemented activities as committeeman and leader in a long list of national and international committees and commissions on chemical analysis, fertilizers, finance and budget, funding of delegates to travel to the Congress of the International Society of Soil Science, the Comite Internationale pour l'Etude des Argiles, and many others.

On September 2, 1937, Marion Jackson married Chrystie M. Bertramson. Four children were born to this union: Marjorie (1938), Virginia (1942), Stanley (1943) and Douglas (1953). Through the years Chrystie Jackson devoted time to assisting Marion in making field observations and in carrying out editorial and logistics work. By faithful support in extensive field sampling travel and attendance with her husband at professional meetings, she has made an important contribution.

Dr. Jackson has taken a personal interest in students and colleagues throughout his career. Many of them mention with enthusiasm the decisive influence he has had on their lives and careers. He is an inspiring conversationalist who loves to discuss scientific matters, relating them to many aspects of present and past environments and to human needs and activity.

We salute Marion L. Jackson in appreciation of his tremendous energy, his well-trained mind, enormous capacity for synthesis, his fertile imagination, his great enthusiasm for inquiry, and his sensitive, warm approach to people. It is a pleasure to look forward to more years of vital sharing and productivity by this inspiring pedologist.

FRANCis D. HOLE