PERSONALITY PORTRAIT—LXXXVII

THEORIST IN HARDROCK

Robert J. Uffen

LAC Uffen is a "wee little one" amongst the many small bodies of water that can't be found on most maps of Quebec Province north of the St. Lawrence River's mouth. Four miles long, Lac Uffen is, and a half mile wide. Professor Robert James Uffen, principal of the University College of Arts and Science of the University of Western Ontario, explains: "That's approximately my shape, which is why they named it after me."

According to the Professor, the lake had to be named after somebody in order to bound a prospecting claim to one of the richest deposits of titanium on earth. And the only somebody in the prospecting crew who might reasonably be mirrored in the lake was Uffen, then a 24-year-old World War II artillery veteran working his way through college. Three other student explorers who shared with him the thrill of coming upon a 150-foot-high cliff of solid ilmanite (titanium ore) from different directions on the same day were not of dimensions appropriate to share the godfathering of Lac Uffen.

This exaggeration is characteristic of Professor Uffen's quiet amusements. For in truth he is long and lean. But the handsome strength of his face is altogether masculine. There is nothing wishy-washy, or even mildly watery, about him. Nevertheless (and this, too, is typical of the man) his account of the naming of Lac Uffen is accurate at every important point.

It happened in the year 1947. The air then was filled with dreams that pure titanium metal would replace both steel and aluminum. Small deposits of the new wonder had been found north of the St. Lawrence near Havre St. Pierre, and New Jersey Zinc Company geologists had tramped over the region the year before. During a summer recess from classes in engineering at the University of Toronto, young Uffen joined a prospecting party headed by Paul Hammond, now one of Canada's foremost geologists, to follow up the New Jersey reconnaissance.

After hacking their way through wilderness along four parallel paths all day, the four students returned to camp and reported, one after another, an astonishing outcrop of magnetic metal that threw their compasses haywire. So rich was the find that two solid weeks were spent in staking claims.

Next summer, again in pursuit of funds to finance his schooling, the student Uffen took part in an aerial survey of the neighborhood of the big titanium deposit; in trailing magnetic instruments through the air above the St. Lawrence, he and others found stretches of rock in which the magnetic alignment was different from that of the surrounding magnetic field.

IN the new theory he is now refining, Professor Uffen has suggested a possible reason for such paleomagnetic contradictions, which are now known to exist all over the earth. This possibility is that early in the planet's history, many small magnetic fields sprang up in response to the churnings of cells of molten iron in earth's core before the core grew large enough to constitute a single, overpowering magnet.

would momentarily cease. The magnetic fields would either collapse or reverse themselves. Such reversals would leave a record of polarization in the rocks, and that record not only exists but has caused more arguments among geologists than almost any other puzzle of earth's crust.

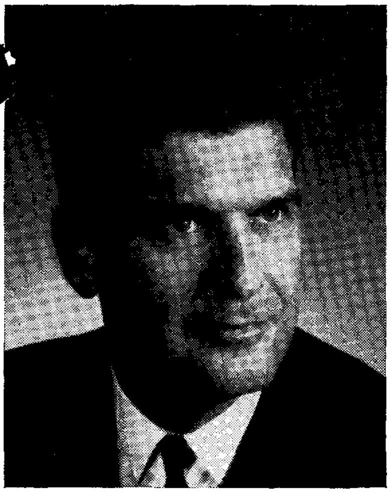
During the next 1,000 million years —from 1,500 million to 500 million years ago—Professor Uffen hypothesizes that life passed through its earliest phases. The magnetic field of the earth became stronger and stronger, holding off those solar radiations that were violent enough to destroy life. The field reversed itself many times, however, in response to the periodic pulsings of heat from the earth's core. During these reversals, the Van Allen radiation belts spilled their cargo of radiation and sped up mutation of the primitive life forms then existing.

Aside from being the first unified theory of biocosmology, Professor Uffen's postulations fill a hole that has gaped embarrassingly at science ever since Darwin formulated the theory of evolution a century ago. Before Professor Uffen set down his ideas in the British journal, *Nature*, several weeks ago, no one had been able to suggest a reasonable mechanism to account for the infinite multitude of evolutionary variations that preceded man's emergence. Sudden bursts of solar radiation would have been as effective for this purpose as X-rays have been in the famous heredity studies of fruit flies.

The length of the evolutionary chain is vastly underestimated by many Americans because of the emphasis that has been thrown on fundamentalist religion's objection to any relationship between men and apes. Until recently, the accepted scientific teaching was that man's development has occurred entirely within the last 500,000 years. Recently archeologist L. S. B. Leakey has found, in Africa, the bones of a manlike toolmaker which radioisotope daters say lived in Tanganyika 1,750,000 years ago. But even that doubled span of time would have been a mere moment by the clock Professor Uffen uses. It is generally agreed, among those students of geophysics and biophysics who speak enough of the same language to understand each other, that whatever total age is assigned to life on earth, at least half of that age was spent in the creation of a single cell.

Professor Uffen will elucidate his theory in detail at the 1963 meeting of the International Union of Geodesy and Geophysics at San Francisco in August. But it is already evident, from the summary he published in *Nature*, that his ideas jibe with those of the famous Russian, A. I. Oparin, who in 1923 proposed that earthly life arose in the neighborhood of 2,000 million years ago from a primeval soup of molecules made up of carbon, hydrogen, nitrogen and oxygen. Oparin said an electrical something—cosmic rays, sunlight, lightning—touched and transformed these molecules. At first, the molecules were just there in the water, part of the environment. Then some of the molecules formed a membrane and so separated themselves from the environment. In time, the membranes became sacs, the sacs became cells, and the cells congregated into complexes which cannabalized unorganized molecules in the water about them.

Beginning very slowly, the life process picked up speed as the available soup thinned. In order to survive, the primitive organisms had to acquire more efficient energy transmission systems, or what are now commonly called metabolisms. And they also had to pass the improvements on to succeeding generations of organisms. It is reasonable to suppose that the first copies were riddled with imperfections. But by some still mysterious method of communication with the environment, the copying became progressively more exact until the patterns with greatest chance of survival emerged. These patterns, it must be noted, were never perfect re-



Bill Barrett—London

Prof. Robert J. Uffen

Many years of thought went into the projection of this third possibility. The thinking might never have been applied in that direction if the young man Uffen who came back from the war had not fortuitously acquired access to two unusual compasses.

One of these remarkable instruments was J. Tuzo Wilson, professor of geophysics at the University of Toronto. The second was A. D. Mizener, the university's professor of physics. Both pointed in the same direction. Genuine understanding of the past and present behavior of the earth, they told their student Uffen, could be reached only by analyzing the chemistry and physics of the earth. In short, the planet should be examined as though it were a heat engine, in which volcanoes served as exhaust pipes and earthquakes shook the ashes from the fire.

An exciting challenge, this, for a tough and determined mind. Well, the Uffens had been accepting such challenges for several generations. Robert's grandfather had fought off the sea as chief petty officer of the Coast Guard at Clovelly on England's Devonshire waterfront. And Robert's father, after working his way to Canada as secretary to the chairman of a Royal Commission on education, stayed on as a functionary in the schools of Ontario Province.

Robert Uffen himself had decided to be an engineer. He got out of the Danforth Technical School in Toronto just in time to be beckoned into the Canadian Army as a private. In 1945, he returned from the fighting, an artillery lieutenant, and spent the next four years under the combined stimuli of Wilson and Mizener at the University of Toronto. In math and physics classes there he met Miss Mary Ruth Paterson, who married him in 1949, the same year in which he won his degree as a Bachelor of Applied Science in Engineering Physics. The first offspring of the wedding was another degree for the bridegroom: Master of Geophysics (1950).

A doctorate in physics, under Mizener, had been next on Uffen's schedule. But Mizener at that point moved to London, Ontario, to head the physics department at the University of Western Ontario. Uffen hesitated momentarily over the risks involved in leaving big Toronto for little London; then he gambled on Mizener and took a place as lecturer on the U.W.O. faculty to earn his keep.

The gamble paid off at fantastic odds. Since collecting U.W.O.'s first Ph.D. in Physics in 1952, Uffen has been: U.W.O.'s first professor of geophysics, first chief of U.W.O.'s department of geophysics, simultaneous chief of U.W.O.'s departments of geophysics and physics (after Mizener's departure from U.W.O. to direct the Ontario Research Foundation), and principal of U.W.O.'s university college of arts and science, which encompasses all the sciences.

As head of the key school on U.W.O.'s campus, Professor Uffen became responsible for budgeting priorities in faculty support of research in one discipline of science versus other disciplines. His personal experience gave him confidence in the physical sciences, but he felt weak in biology. To inform himself, he sat in on biology lectures. As he listened to these, patterns of new thought began to assemble and he entered the last phase of his theory on the related origins of earth and man.

ALTHOUGH his ideas have yet received small public attention in the United States, Professor Uffen is known to leading geophysicists of the country through associations begun when he was a postgraduate fellow at University of California's Institute of Geophysics ten years ago. Elsewhere in the world of science, he is recognized for his vigorous pioneering as chairman of the committee charged with planning and executing Canada's share of current global studies of earth's mantle. Within Canada, he ranks at the topmost level of science, for ten years past being a Canadian delegate to the International Union of Geodesy and Geophysics and more recently a member of the National Research Council of Canada and the Defense Research Board of Canada.

Among researchers, Professor Uffen has a formidable reputation for research. Among teachers, he is applauded as a spontaneous fountain of inspiration.

His wife's role in this seemingly impossible concatenation of virtues is evident only in his voice as he speaks of her; it is so effective it does not show itself to strangers. The children (Joanne. 11; Robert, 9) are simply "like children are, bright enough to get into mischief sometimes." They play the piano. Their father paints sufficiently well to be president of the Western Art League. What does he paint? "Oh," he says, "I paint for fun, and it always comes out conservative."

—WILL JONATHAN.

productions; had they been so, evolution would have stopped at the point where perfection was reached; small variations had to be built into every model to prepare for unpredictable future shifts in the environment.

One of the important early innovations in the pattern-making were the porphyrins, dyes that grabbed up light with great agility. Into the skeletal structure of these molecules, like flesh on bone, iron and magnesium atom fragments found their way. The iron combined with oxygen readily, hence could carry oxygen through the red cells of the blood of air-breathing animals. Such a hemoglobin transport system ultimately would carry more energy than any other. But before the hemoglobin could be used, there had to be oxygen to breathe and lungs to breathe it.

At the time we are here speaking of, there was little if any free oxygen in earth's atmosphere. That lack continued, as far as we know, until the porphyrins incorporated magnesium into their structure. The magnesium (which, incidentally, came like the iron from the depths of the planet) could pick up electrons from the sunlight and pass the electric spark along as food for the tissues of green plants that sprang up on the land. These growing green organisms inspired carbon dioxide and expired oxygen. The exchange not only revolutionized the composition of earth's atmosphere but, more importantly, created within the atmosphere a thick spherical shell of ozone (three-atomed oxygen) which screened out the most destructive wavelengths of ultra-violet sunlight that had got past the earlier established magnetic barriers described by professor Uffen.

In the grand sense, then, what the Uffen theory does is push backward across millions of years of time the beginnings of powerful natural phenomena which cupped the hands of nature, as it were, around the flickering matchhead of life. For metabolic systems had progressed a very long way from the first cannabalistic molecules imagined by Oparin to the place in time where the flowering plants expired enough oxygen to remake the atmosphere. Bacteria, thought of as primitive life forms today but actually extremely complicated creatures, had developed to their present state under the old regime. So had algae. The firefly and the electric eel may be relics of transition from those oxygen-starved times; because when oxygen first became plentiful it must have been a poison; to survive it, then living organisms had to break it down at once, and they did this by releasing some of its energy in flashes of light.

TODAY, after millions of years of biological evolution have improved upon billions of years of biochemical evolution, what once was a direct and immediate response by a living organism to the environment has become, in the human animal, reaction at an incredible distance from the natural surroundings. The metabolic machinery has become so delicately organized that a cell in the human body would be stunned if not killed outright by the energy of sunlight. The current of electrons is subtly switched at myriad points to minimize loss of power everywhere along the circuit of survival.

Laboratory experiments prompted by publication of an English translation of Oparin's ideas in 1938 have since demonstrated the reasonableness of that famous Russian's theories. First Dr. Melvin Calvin and then Dr. Harold Urey's student, S. L. Miller, and subsequently others proved that electric charges introduced into a soup of common hydrocarbon molecules in absence of oxygen would indeed create amino acids, the building blocks of life. And Dr. Sidney Fox has further produced cell-like globules by applying heat to molecular soup prepared according to Oparin's recipe.

There was a time, not too long ago, when biologists looked upon the cell as a tiny bagful of fluid. Everything worthwhile that happened in the cell was assumed to happen in the fluid. However the electric current of life might pass, it had to pass in ionic form; the charges had to move through the solution. But this conception has been radically revised by the electron microscope. By revealing details too minute to be seen directly in optical images, the ultra-magnified electronic shadows have opened a new research frontier on the cell membrane. What once seemed a plain and simple bag is as convoluted as a sheet of corrugated cardboard. Across such a surface, energy could easily be transported according to the laws of solid state physics. The more that is learned about it, the more the cell wall appears to be what Nobelist Albert Szent Gyorgyi a quarter century ago predicted it might be—a semi-conductor of electricity.

The significance of the semi-conductor in this context is as follows. While able neither to transmit current freely (as electrical conductors do) or to block the passage of current entirely (as insusulators do), a semi-conductor can manipulate electricity selectively; current can be caused to flow in one chosen direction only, and the amount of power being passed can be amplified or reduced by degrees specifically indicated through gentle signals. Such a switching system obviously fits the needs of man and other animals dependent on remotely controlled reaction to their surroundings.

The most direct and complete evidence of operation of a semi-conducting system within the body has been published in the last few months by a team of three researchers: Dr. Robert O. Becker, orthopedic surgeon of Syracuse, N.Y.; Dr. C. Andrew L. Bassett, orthopedic surgeon of New York City, and physics professor Charles H. Bachman of Syracuse University. These men subjected pieces of bullfrog, rat, dog and human bone to physical stress in laboratory apparatus and uncovered the long hidden mechanism by which bone changes its shape in the particular directions required to withstand particular weights and pressures and strains. The mechanism was analogous to the p-n junction of a transistor.

The letter "p" stands for "positive," the letter "n" for "negative." In p-type semi-conductors, there is a positive current, in n-type semi-conductors a negative current. Junction of the p-type and n-type regulates traffic in a one-way only pattern. And this is what happens in bone, which has two principal constituents—apatite mineral and collagen. Apatite is p-type, collagen n-type. Messaging between the two proceeds most efficiently at the normal temperature of the body. When word of stress from a particular direction is received, collagen fibers—which are always present—line up at the strategic point to answer the challenge by strengthening the bone. Small amounts of water play a mediating role in the process, just as the water did in Oparin's hypothetical primeval soup. The Becker-Bassett-Bachman experiments suggest that vitamins and hormones perform the same function in bone growth as is performed by impurities deliberately introduced into transistors made of germanium or silicon: they speed up the transfer of electrons.

Now that we know how it is that our bones withstand the strain of carrying us where we need to go in answering environmental demands, it would be satisfying to understand how our muscles are guided to move these bones. Happily, this part of the story is already on the record. Several years ago, Drs. Becker and Bachman and another collaborator, psychiatrist Howard Friedman of New York State University, experimented on the central nervous systems of salamanders and frogs. It was discovered then that an electric current flowed inward along the sensory fibers which carry information gathered by the eyes, ears, nose and skin—the descriptions of what is seen, heard, smelt and felt (pressure, heat, pain). Along the fibers of the motor nerves which command the muscles to contract and expand and move the animals about in response to this information, another electric current was found flowing oppositely. Here, apparently, were the complementary halves of one electrical circuit. Their presence contradicted previous determinations that no flow of electricity was involved in the lightning-like action of sensory or motor nerves. However, Dr. Becker confirmed the presence by blocking the nerve pathways with local anesthetics; when the nerves went to sleep, the flow of current stopped.

"WE think the current we detect is the most primitive guidance system within man's body," Dr. Becker wrote in SR/Research for February 3, 1962. "It was through this system, we believe, that the environment instructed our oldest ancestors in what behavior they should follow in order to survive on earth."

In support of this view, Dr. Becker and his fellow researchers correlated the rate of admissions of patients to several mental hospitals with the daily and monthly fluctuations in earth's magnetic field. The resulting tables of figures were fed into a computer, which reported direct and very close relationships between the most dramatic form of disturbance to the human central nervous system and changes in the magnetic field of the planet.

It may be that Canada's Professor Uffen, in formulating his theory about the midwife's role of earth's magnetosphere in the birth of man, has hit upon something even bigger than he supposed. The mystery remains: Whence did Oparin's primeval soup come from? For an answer from Oparin's homeland, read on to the next page.

—JOHN LEAR,
Science Editor.

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THE RESEARCH FRONTIER

U.S.S.R. Academy of Sciences—by Sovfoto

WHERE IS SCIENCE TAKING US? *Where, indeed? Most discussants of the question of life's origin on earth assume that the living process began with hydrocarbon molecules in the surface waters of the young earth, and that one of the by-products of the process was formation of petroleum by living organisms, primitive creatures of the sea perhaps. Could it have happened the other way 'round? Might the pools of petroleum which are now found below the surface of the planet have originated from violent upheavals within the juvenile earth? Might some of the petroleum hydrocarbons have reached the crust and there have become the starting material for the primeval "soup" of life? The argument below is taken from the Pergamon Press book, "Aspects of the Origin of Life," edited by M. Florkin, president of the International Union of Biochemistry (Copyright © by Pergamon Press).*

P. N. KROPOTKIN
Geological Institute, U.S.S.R. Academy of Sciences

ALL modern investigations of the origin of life lead to the conclusion that the source of primary, most primitive forms of life on earth was abiogenic [lifeless] organic compounds of the complex hydrocarbon type. Among the organic material widely distributed in earth's crust that could be considered as a source of the primary forms of life is petroleum, or complex hydrocarbons similar to it in composition.

Most investigators assume that earth's atmosphere originally contained no oxygen. Free oxygen appeared later, as a result of the life activity of plants. Evidently, reducing chemical conditions [those in which chemical compounds are stripped of oxygen and thus brought to a pure elementary state] were predominant in the atmosphere at that time. Besides a certain amount of methane, there were probably carbon dioxide, nitrogen, and aqueous vapor in the atmosphere.

Developing in such conditions at the surface of dry land or water basins, the primary living organisms evidently could neither make use of solar energy (not yet having acquired chlorophyll) nor of the energy which under present conditions is freed through oxidation of organic compounds in the atmosphere or in water containing molecular oxygen (for instance, in processes of putrefaction). It would appear that chemical processes at that time were of the type now effected by anaerobic [those which live without free oxygen] bacteria.

Two types of exothermic [heat releasing] reactions may be considered as prototypes of the processes through which the vital activity of the primary organisms could have taken place. The first type of reaction is carried on by anaerobic bacteria during the decomposition of organic matter in water basins in conditions of a reducing chemical medium, methane being formed [from hydrogen and carbon] at the expense of more complex organic compounds. The second type of reaction is brought about by desulphurizing petroleum bacteria in the presence of petroleum and water.

Petroleum bacteria, discovered by T. L. Ginzburg-Karagicheva in the petroleum of the Apsheron Peninsula, and by Bastin in the Pennsylvania oil (U.S.A.), are found in wells from 2,400 to 9,000 feet deep. They breed most abundantly near the interface where the petroleum comes in contact with waters underlying it, these waters usually being of the sulphate-chloride type. It is known that the sulphates in these waters are of inorganic origin and are derived partly from the salt residue in the marine sedimentary strata, and partly, possibly, from mineralized waters of more abyssal genesis.

Similar conditions, in principle, could have arisen in the Archaean era [3,500 million years ago] at the surface of lagoons or other water basins, if the water was covered with a film of oil. It should be noted that the oxidation of oil [which now rapidly leads to the formation of resin, polymerization of bitumens, and transformation of petroleum into asphalt] at that time did not as yet take place because of the lack of oxygen. Consequently, conditions favorable for the reduction of sulphates in sea or lake waters, with petroleum present, could have been maintained for a considerable time.

The pattern of origin and development of life outlined above could be considered only if the sources of large quantities of petroleum [or of abiogenic hydrocarbons similar to oil in chemical composition] were known. The origin of petroleum has been debated for 100 years and is one of geology's most controversial problems.

The hypothesis that petroleum is of inorganic origin was first put forward by V. Sokolov in 1890. Highly popular at first, it was developed by D. I. Mendeleev, M. Berthelot, H. Moissan, E. Coste, and others. Later, it seemed to have been completely abandoned. This was especially so during the 1920's and 30's, when there appeared the investigations of C. D. White, P. D. Trask, and others in the U.S.A., of I. M. Gubkin, G. L. Stadnikov, and A. D. Arkhangelskii in the U.S.S.R., and so on. [All of whom argued that petroleum was a product of decay of organic matter, particularly of marine organisms].

RECENTLY, geologists have again become interested in the inorganic hypothesis. In 1951, N. A. Kudryavtsev criticized the organic theory and put forward serious arguments in favor of inorganic origin of petroleum. At the 1954 Lvov Conference dedicated to problems of the origin and migration of oil, two reports in favor of the inorganic hypothesis were submitted. In the United States, the inorganic hypothesis was supported by Macdermott and such well known specialists as Van Tuyl, Parker and Van Orstrand. At the same time, ideas connected with the organic hypothesis were developing in such a way that they began to contradict one another. In our mind, these contradictions reveal a profound crisis into which the organic theory has come.

Oil fields are usually found in regions which possess natural gas deposits (methane, with a certain amount of ethane and heavier hydrocarbons), sometimes in mixed oil and gas deposits, forming together definite oil and gas provinces (petroliferous provinces). Geological investigation of these districts shows that both their general outline and the location of separate deposits of petroleum and gas are determined not by the presence or absence of sedimentary rocks rich in biogenic organic substances (for instance, coal, carbonaceous and bituminous shales), but