

Joseph V. Smith

Louis Block Professor of Geophysics
The University of Chicago



Edited by Virginia A. Smith

Note on this memoir

At the time of his death, Joe Smith was completing a book entitled *Living Safely*, part-memoir, part-ecological treatise, about how people can—and must!—protect the Earth and themselves from environmental dangers.

For this book that commemorates his life, I have included only the autobiographical parts of his book. For those wishing to read the entire manuscript, please contact me at VAHSmith@aol.com.—Virginia Smith

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Joseph V. Smith, 78; was award-winning mineralogist

By Alice Dembner
GLOBE STAFF

Early in his scientific career, geophysicist Joseph V. Smith found himself without a critical research tool. Unfazed, he built the needed X-ray generator from junk and chicken wire.

Dr. Smith brought that same no-nonsense ingenuity and determination to wide-ranging work that helped explain the origins of the moon and increase the yield of gasoline from oil.

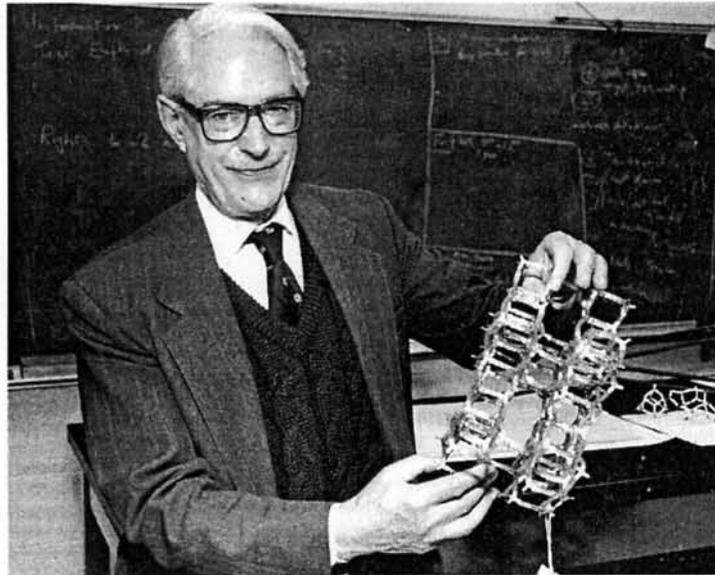
"I'm a farmer's boy," Dr. Smith often said. "You get up in the morning and do what needs to be done."

Dr. Smith, a professor at the University of Chicago, died April 6 at Beth Israel Deaconess Medical Center of pneumonia. He was 78 and had moved to Brookline with his wife Brenda in late 2005 to be closer to his older daughter, Virginia Smith and her family.

In early 2006, after he fell and broke his hip while fixing Brenda's computer, he agreed to participate in a Boston Globe special report on the difficulties older patients face after hip fracture. Dr. Smith, who was then suffering from Parkinson's disease, fought his way back not only from the hip fracture, but from several heart attacks, returning home to work on a book about global warming.

"He was very strong and very stoic," said his wife. "He handled any difficulties in life the way he handled his illness."

Born in Derbyshire, England, he won scholarships to exam schools by studying old tests and reading science textbooks. He earned a doctorate in physics from Cambridge University and moved to the United States in 1951 with his wife. He taught briefly at Pennsylvania State University before moving to the University of Chicago, where he became a tenured



Joseph Smith was among the first scientists to analyze rocks brought back from the moon by the Apollo 11 mission.

full professor at the age of 32. He specialized in the crystal structure of minerals.

Dr. Smith wrote a definitive book on feldspar, one of the most abundant minerals in the Earth's crust. His work on porous minerals called zeolites led to improved techniques to harvest gasoline from petroleum and to make laundry detergents more environmentally sound by replacing phosphorus. He also was among the first group of scientists to analyze rocks brought back from the moon by the Apollo 11 mission, helping to unravel the moon's geologic origins.

"Joe was one of the great mineralogists of his time, both in an intellectual sense and a practical sense," said Peter Wyllie, a former geology colleague at the University of Chicago who is now retired from the California Institute of Technology. "He did first-rate science that was always at the forefront. And he pursued practi-

cal applications in a very powerful way."

Wyllie said Dr. Smith was also "always looking for the next, best way of studying minerals." In the early 1960s, he helped refine the electron microprobe, a tool used to identify the chemical makeup of solids. And in the 1980s, he helped found a center to promote access for scientists to a high-energy particle accelerator at Argonne National Laboratory in Illinois.

In 1982, he won the Roebling Medal for outstanding research, the highest award of the Mineralogical Society of America. He was also a fellow of the Royal Society, the scientific academy of the United Kingdom.

Dr. Smith described himself as impatient with students who required spoon-feeding, but he sought out poetry about rocks to help teach nonscientists about geology, according to his wife.

Throughout his life, he was

concerned about the stewardship of the earth. In his speech accepting the Roebling Medal, he made a plea for shifting funds from "war machines" to science and maintained that "international ties between scientists can help establish that we all belong to one human race, and must learn to live in peace on this planet."

In recent years, he was working on a book that is part memoir, part ecological manifesto. In it, he said that society is wasting resources on war instead of protecting itself against hurricanes, tsunamis, and asteroids.

In his home life, he tried not to waste a minute and nearly always multitasked, doing a crossword puzzle while talking with his doctor, for instance. In Brookline, he often called across the street to recruit his grandson for a game of chess. He frequently strolled around the pocket park adjacent to his house and helped his daughter plant bulbs there last year.

Dr. Smith loved to travel and made frequent trips to the family farm in England as well as several cross-America drives. The focus of the trips was often geology, his wife said, which led to stops at the Grand Canyon, but also at more obscure locations such as a boulder field in Washington State.

"He was absolutely fascinated by most things and if it had a rock in it, it was even more fascinating," his wife said.

In addition to his wife and daughter Virginia, Dr. Smith leaves another daughter, Susan Smith Werther of Madison, Wis.; a brother, Frank of Whatstandwell, Derbyshire; a sister, Hilary Wellby of Crich, Derbyshire; and four grandchildren.

Funeral services are planned for late June in Crich. A memorial service will be held at a later date in Chicago.

OBITUARY FOR JOSEPH V. SMITH



Joseph Victor Smith died of pneumonia at the Beth Israel Medical Centre in Boston on 6 April 2007, at the age of 78. He was born on 30 July 1928 and raised on a hill farm in the Peak District of Derbyshire in the north of England. With the encouragement of his mother and uncle, both teachers at a school not noted for its academic successes, Joe won an open scholarship to Cambridge where he obtained a first-class honours degree in physics. After post-graduate work on the crystallography of calcium carbonate-silicates, he spent some time at the Geophysical Laboratory in Washington where he was influenced

by W.S. Mackenzie (who, Joe said, gave him his lifelong interest in feldspars), Hat Yoder and Felix Chayes. After a brief return to Cambridge, Joe went to Penn State where he began work in earnest on feldspars and also became involved, via his consultancy with the Union Carbide Corporation, in zeolites – the molecular sieves that have proved so successful in improving the yield of gasoline from oil and producing phosphate-free detergents. He moved to the University of Chicago in 1960, becoming a full professor at the early age of 32.

One of his early achievements in Chicago was the building of one of the first operating electron microprobes. In those early days, there was considerable scepticism as to whether such probes would ever deliver meaningful results, but its routine use these days is a legacy of a few imaginative pioneers, one of whom was Joe. He was concerned not just with the numbers obtained but also with what they meant; for example, he noted the low Ca concentrations in mantle olivine, due to high pressures, compared with the higher amounts in its volcanic equivalent. In 1965, Joe started the Short Courses in Mineralogy, run in conjunction with the annual meetings of the Geological Society of America. These, and the accompanying Reviews in Mineralogy, published by the Mineralogical Society of America (the first 40 being edited by Paul Ribbe), continue to the present day with the added involvement of the Geochemical Society. In 1969 Joe became a Principal Investigator in the Apollo Programme, which led him to another interest: planetary geology and mineralogy. As if this were not enough, in the early 1970s he became involved in research on upper mantle mineralogy. His later interests included threats to mankind through meteorite collisions with the Earth and global conflict, but these went hand-in-hand with his fundamental interest in new technology and what it could do for mineralogy and crystallography. He became interested in the role of mineral surfaces in the origin of life, a subject on which he wrote an article for *Elements* (Volume 1, issue 3). He was involved with Bob Clayton in setting up the ion probe at the Enrico Fermi Laboratory at the University of Chicago. Another major achievement was when he organised a multi-institutional, multi-disciplinary group of scientists and founded the Consortium for Advanced Radiation Sources to use the Advanced Photon Source at the Argonne National Laboratory. His research has resulted in over 400 publications in most of the major journals and includes his three encyclopaedic books on feldspars.

Among the many honours he received for this work were his election to the fellowship of the Royal Society of London and the National Academy of Sciences, and the award of the prestigious Roebling Medal of the Mineralogical Society of America and the Murchison Medal of the Geological Society of London.

So much for Smith the scientist. What of Smith the man? He was one of the most multi-faceted men I have met. Intensely curious, he was interested in literature, art and music; one of the pleasures of visiting Chicago in the autumn was the weekly trips downtown with Joe and Brenda to hear concerts of the Chicago Symphony Orchestra. He was



Joe and Brenda Smith collecting weathered feldspars at Shap in the north of England in 2000

also a prodigious reader, and not only of the scientific literature. He lived life intensely and, being an extremely dedicated and well-organised man, he was sometimes held by students to be a hard taskmaster. Those who knew him better recognised that this was only because he took it for granted that students and collaborators should be prepared to work as hard as he did himself. I can say personally that his rigorous working to deadlines was good for our collaboration. Even off duty, Joe's unbridled energy meant that he could hardly relax completely and, in the early days when the Derbyshire farm was still in family hands, he returned to England each summer, not only to show his daughters the rural and architectural heritage of Britain, but also to help his father and his brother with the hay making. He was very loyal to family and friends. In later years, he and Brenda spent weekends at their lovely home on the shore of Lake Michigan in the Indiana Dunes Park, where they took great pleasure in entertaining friends from many parts of the world – but there were always jobs like installing a new rain-butt and fence-making to be done.

With his passing, the mineralogical community has lost one of its most productive and influential members. All the same, I like to imagine Joe is up there, building another probe, just to find out what the Pearly Gates are really made from!

Barry Dawson
University of Edinburgh

JOSEPH V. SMITH | 1928-2007

U. of C. prof was noted mineralogist

Had ground-breaking theory on how moon was formed

BY LARRY FINLEY

Staff Reporter/lfinley@suntimes.com

Joseph V. Smith was one of the country's preeminent mineralogists, and his interests stretched to the moon and back again.

As a University of Chicago professor, Mr. Smith was among scientists asked to analyze the moon rocks brought back to Earth by the Apollo 11 crew in 1969. His conclusion was that the moon had once been a ball of molten lava that was later pummeled by meteorite impacts.

Mr. Smith, 78, died April 6 of pneumonia at Beth Israel Deaconess Medical Center in Boston, after a five-year battle with Parkinson's disease. He taught and did research at the University of Chicago from 1960 to 2003 in a wide variety of areas related to minerals.

Alfred Anderson, professor emeritus of geophysical sciences at the University of Chicago, described Mr. Smith as "a man with his eye . . . on new ideas."

"When I came to the university, he was doing some of the moon work planning and he graciously included me," Anderson said. "He was instrumental in performing some of the early mineralogical analysis and interpreting them."

Mr. Smith's model of a "hot moon" has gained increasing support over cooler models in explaining the origins of the universe.

In a 1999 interview, he said, "There had to have been tremendous colli-

sions. There's no way the moon could have got where it was without melting. This was heresy in those days,"

Mr. Smith liked to recount how as a child growing up on a farm in England, he would look up at the moon and wonder why part of it was black and part was light. Then as a scientist he got to study pieces of the moon and discovered they were solidified lava with different components.

"Joe was always very conscious of his roots," said Keith Moffat, professor of biochemistry and molecular biology at the University of Chicago.

"I've heard that story a dozen times. He never lost his roots and that's good."

"He was a visionary," Moffat said. "He was brilliant. He was very aggressive in advocating his point of view."

Won many honors

Mr. Smith was born July 30, 1928, in Derbyshire, England. He won a scholarship to Cambridge University, where he received a B.A. with first-class honors in 1948, and a Ph.D. in physics in 1951. He married his wife, Brenda Wallis, on Aug. 31, 1951.

He began his research career at the Geophysical Laboratory of the Carnegie Institution in Washington, in 1951, returning to teach at Cambridge in 1954. From 1956 to 1960 he was a faculty member at Pennsylvania State University, where he began his research on feldspar minerals. He joined the University of

Chicago faculty as a full professor in 1960 at the age of 32.

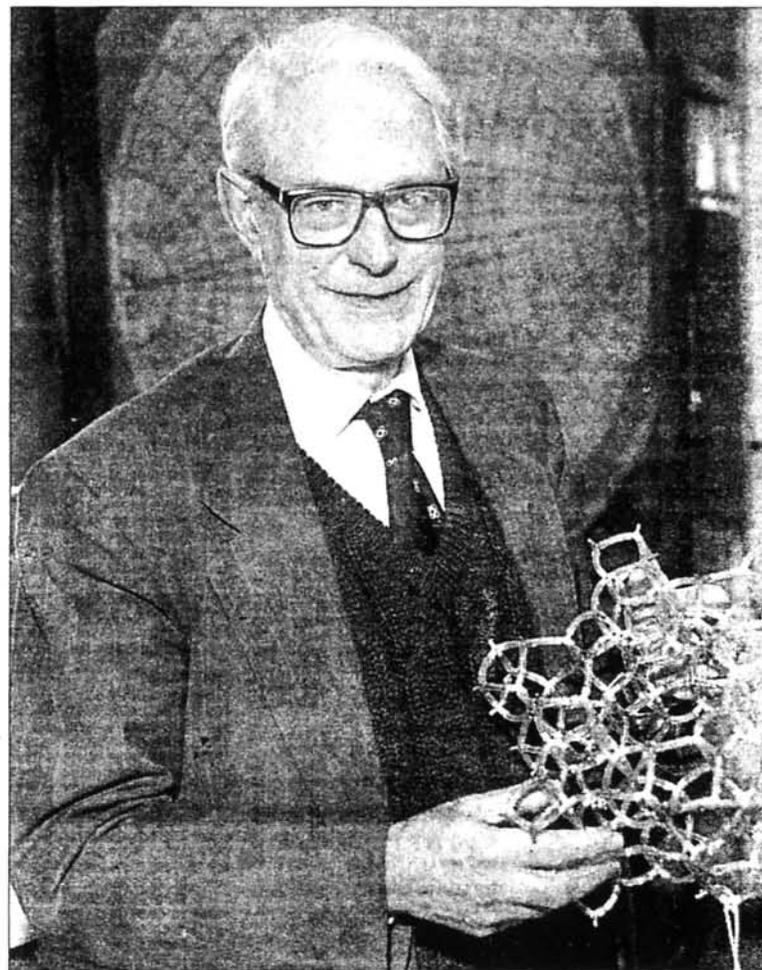
"I knew him through his work with what became known as the Consortium for Advanced Radiation Sources," said Moffat. "In 1990, it was clear the U.S. Department of Energy was going to build at Argonne Lab a splendid new X-ray source. Which they did and it's known as the Advanced Photon Source."

The generator is "the premier X-ray source in America and arguably in the world because of its unusual characteristics," he explained. Professor Smith predicted that it would be in great demand for research and set up a method for assigning its use.

"Joe had extremely broad scientific interests," Moffat said. "Although he is by background an earth scientist and mineralogist, he had interests that extend far beyond that to chemistry, material science and elements of biology."

For much of his career, Mr. Smith served as a consultant to Union Carbide Corp. and UOP LLC, because of his expertise in zeolites, minerals that have a micro-porous structure. They can be used as molecular sieves to improve the yield of gasoline from oil and produce phosphate-free detergents.

His many honors include election to the National Academy of Sciences, and medals from the Geological Society of London and the Mineralogical Society of America.



Joseph V. Smith was nationally famous in his field. His interests went beyond mineralogy and included chemistry and biology.

Survivors include his wife, Brenda; two daughters, Virginia Smith and Susan Werther, and four grandchildren.

He will be buried in Derbyshire in June. A memorial service will be held at Bond Chapel at the University of Chicago later this year.

Obituaries

Early curiosity helped shape Smith's geophysical sciences career

When Joseph Smith was a boy on his parents' farm in the north of England, he would pull away from his farm work, look at the moon and wonder why part of it was white and part was black.

Years later, Smith found himself conducting tests on Apollo 11 lunar samples. In early December 1969, the answer to his boyhood question about the moon's colors lay on him. The white material was rock enriched with feldspar. The black material was basalt, solidified lava.

Smith realized that feldspar crystals, being lighter than basalt, probably floated to the highland areas of the moon when the planet was a ball of molten lava. The moon's crust must have been extensively melted, Smith concluded, in a series of catastrophic meteorite impacts.

"There had to have been tremendous collisions. There's no way the moon could have got there it was without melting. This was heresy in those days," Smith said in a 1999 interview, recalling a prevailing theory of 1970. His model of a "hot moon" has gained increasing support over the cooler models and has led to a greater understanding of the origins of the solar system.

Smith, the Louis Block Professor Emeritus in Geophysical Sciences and the College, died of pneumonia at Beth Israel Deaconess Medical Center in Boston on Friday, April 6, after a

five-year battle with Parkinson's disease. He was 78.

Author of more than 400 scientific articles, Smith also wrote *Geometrical and Structural Crystallography*, and a three-volume scientific reference series on feldspar minerals.

"Feldspars are the most abundant, most important minerals in the crust of the Earth, and Joe Smith was the world authority on those minerals," said Robert Clayton, the Enrico Fermi Distinguished Service Professor Emeritus in Chemistry, Geophysical Sciences and the College. Smith also studied an industrially important mineral group called zeolites, as well as volcanism in east Africa and lunar geology, said J. Barry Dawson, professor emeritus of earth science at the University of Edinburgh. "A very multifaceted man was Joe," Dawson said.

For much of his career, Smith served as a consultant to Union Carbide Corporation and UOP for his zeolite expertise. Smith helped industry harness zeolites as molecular sieves to improve the yield of gasoline from oil and produce environmentally friendly, phosphate-free detergents.

In the early 1970s, Smith collaborated with Dawson in analyzing the composition of rocks and minerals brought to the Earth's surface from the upper mantle, the layer below the outer crust. Their studies identified the first sample of

diamond in garnet lherzolite, a solid rock from the mantle. Their work showed that diamond formation was not connected with volcanic activity, which geologists had previously assumed.

Smith also was an entrepreneur in the development of scientific instruments, Clayton said. At the Carnegie Institution of Washington in the early 1950s, Smith built an X-ray generator out of junk equipment and chicken wire.

When Smith arrived at the University in 1960, he immediately built an electron microprobe for the Department of Geophysical Sciences. "Now every geology department has to have an electron probe, and the department here was one of the first to get it," Clayton said. "He was a real pioneer in developing the instrument."

As a visiting physicist and consultant to Brookhaven National Laboratory in New York since the mid-1980s, Smith helped develop a microprobe for precision X-ray analyses of experimental samples. And in the early 1990s, he organized a multi-institutional, multidisciplinary group of scientists to found the Consortium for Advanced Radiation Sources to use the Advanced Photon Source in their research. The U.S. Department of Energy's APS at Argonne National Laboratory provides the most brilliant source of X-ray beams for research in the Western Hemisphere. Smith directed CARS from its founding until

1993.

Smith was born July 30, 1928, in Derbyshire, England. He received a B.A. with first class honors in natural science in 1948, and a Ph.D. in physics in 1951, both from Cambridge University. Smith married his wife, Brenda Wallis, at St. Mary's Church, Crich, Derbyshire, on Aug. 31, 1951.

He began his research career at the Geophysical Laboratory of the Carnegie Institution in Washington, in 1951, returning to teach at Cambridge in 1954. From 1956 to 1960 he was a faculty member at Pennsylvania State University, where he began his seminal research on feldspar minerals. He joined the Chicago faculty

as a full professor in 1960 at the age of 32.

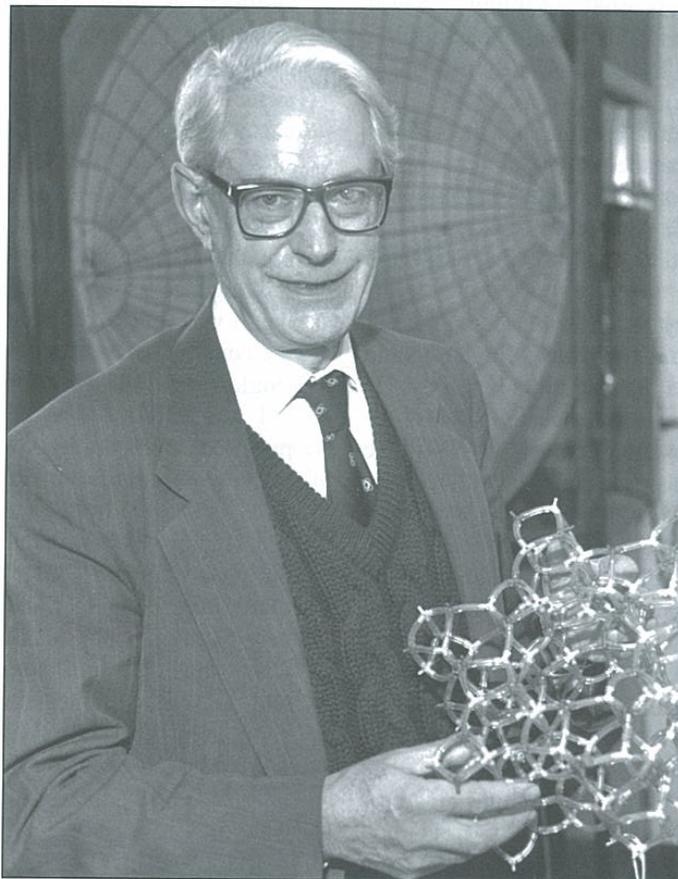
Smith received many honors during his career, including election to the National Academy of Sciences, the Geological Society of London's Murchison Medal and the Mineralogical Society of America's Roebling Medal and MSA Award.

Smith is survived by his wife, Brenda Smith, of Brookline, Mass., and two daughters, Virginia Smith, Brookline; and Susan Werther, Madison, Wisc.; and four grandchildren.

He will be buried in Crich, Derbyshire, in June. A memorial service will be held at Bond Chapel later this year.

Obituaries

JOSEPH V. SMITH 1928–2007



Joseph V. Smith was born on the 30th of July 1928, in Derbyshire, England. He married Brenda Wallis at Crich, Derbyshire, on the 31st of August, 1951, moved to the USA, and their family grew with two daughters, Virginia and Susan. He retired in September 2005 as the Louis Block Professor Emeritus in Geophysical Sciences and the College at the University of Chicago. On Friday the 6th of April, 2007, at age 78, he died of pneumonia at Beth Israel Deaconess Medical Center in Boston. Parkinson's disease had begun to take its cruel toll about five years earlier. He and his wife Brenda moved to Brookline in 2005 to be near their daughter, Virginia, and family, where he suffered a broken hip and several heart attacks before the final event. In the meantime, he continued to write an autobiographical book

Living Safely which dealt with local and global problems facing our species. As Brenda said: "He was very strong and very stoic. He handled any difficulties in life the way he handled his illness."

In early April, a reporter from the Boston Globe asked me, by phone, for information about Professor Smith. From my troubled, garbled conversation the reporter recovered the following quotation: "Joe was one of the great mineralogists of his time, both in an intellectual sense and a practical sense. He did first-rate science that was always at the forefront. And he pursued practical applications in a very powerful way. He was also always looking for the next, best way of studying minerals." His many honours support these statements. These include election as Fellow of the Royal Society of London and member of the

US National Academy of Sciences, and award of the Murchison Medal (Geological Society of London), the MSA Award (young scientist award of the Mineralogical Society of America) and the Roebling Medal (the highest research award of the Mineralogical Society of America). He published at least four books and more than 400 scientific papers that spanned several disciplines. There is a mineral, joesmithite, named in his honour by Paul Moore, in 1968 (a plumbous amphibole). Below I have taken the opportunity to offer more comments with outlines of his education, his academic and administrative appointments, his work developing instruments, his books, some of his research programmes, and his concerns about stewardship of the Earth and its inhabitants.

Joe Smith was very proud of his first 17 years living on a farm in Derbyshire, England, and always maintained that he was still a farm boy. He attended village schools, and because he was the only candidate for the Cambridge Entrance Examinations, he was excused from all classes so that he could study on his own. He worked through all the Entrance Exams from the previous 30 years and won a scholarship to Gonville and Caius College. His admission to Cambridge University in 1945 would have been considered a triumph for his school. In Joe's own words: "My competitors came from famous public schools such as Eton, Harrow and Winchester and long-established grammar schools. The country mouse was awed but not intimidated." He earned a B.A. (first class honours) in Natural Sciences in 1948, and advanced to a PhD in crystallography in 1951. He reported "superb teaching" for undergraduates, but found his assigned computations for the structure of calcium carbonate minerals so tedious that he almost quit the academic path. However, he liked the research environment and faculty associates, so he persisted.

William H. Taylor recommended him for a Fellowship at the Geophysical Laboratory of the Carnegie Institution of Washington, and Joe concluded later that this was "perhaps my greatest good fortune". In fact, his greatest good fortune came first when he "rushed home to get married to Brenda Wallis, a beautiful and intelligent girl from Fritchley, Derbyshire. We had been at Fritchley elementary school, where she later told me that she had picked me out for a husband at the age of ten!" They married, and sailed to the USA on the *Queen Mary* in 1951.

For Joe, the Geophysical Laboratory was an intellectual and experimental mecca. He credited his new colleagues W.S. MacKenzie, O.F. Tuttle, H.S. Yoder and F. Chayes for educating him to some extent in Earth Sciences while still remaining "green as grass. Geology was baffling ...". He reported that he found rather primitive facilities for crystallography compared with those at his training grounds in Cambridge University, so he had to build his own X-ray generator from miscellaneous old equipment, chicken wire, and a cocoa tin at a cost of \$2. When asked why he had such a fine pair of experimental hands, he would explain that thanks to his upbringing on a farm, he was one of the few crystallographers who could obtain satisfaction from sitting on a stool and milking a cow, the old-fashioned way. He claimed that it was this kind of training that guided him in the construction of his generator that yielded four single-crystal diffraction photos a day.

I was introduced to J.V. Smith in a series of papers on feldspars by MacKenzie and Smith that were required reading during my honours year and as a graduate student. William Scott MacKenzie had been the Teaching Assistant during my undergraduate years at the University of St. Andrews, Scotland, and he had made his way to the Geophysical Laboratory in 1952, *via* Cambridge. He introduced Joe to the feldspars, and the combination of Joe's knowledge of solid-state chemistry and physics with Mac's knowledge of minerals and rocks generated a remarkable series of papers, and a life-long friendship. That was when Joe realized that he must learn petrology and geology.

Before examining his developments with instruments and broader Earth and Planetary Sciences, let us preview his successive travels and appointments. After Washington, the Smiths returned to Cambridge where Joe was a Demonstrator between 1954 and 1956. Then, Frank Tuttle invited Joe to join him as Assistant Professor in the Division of Earth Sciences at Pennsylvania State University, which had become home for several former Geophysical Laboratory scientists. Joe did not want to leave England, but in his own words "on checking around, no suitable tenured position was available. Oxford paid strictly by age, and my advanced experience did not count; Bristol decided that I would be better off at Penn State; and Cambridge stated that no tenured positions would be available for some years". English newspapers at that time were full of stories about the 'brain-drain', and the Smiths

joined the movement in November 1956. That was when I first met the Smiths in person, because Harald Drever (St. Andrews) and MacKenzie had arranged for me to join Frank Tuttle as research assistant in 1956, while I completed my St. Andrews PhD. I returned to Leeds University in 1959, and the Smiths moved on to the University of Chicago in 1960; Joe was full professor at the age of 32. I returned to Penn State in 1961, and was in turn enticed to the University of Chicago by Joe Smith and Julian Goldsmith in 1965. We shared 18 years together in the intimate community of Hyde Park, with growing families and scientific goals. After my family moved to the California Institute of Technology in 1983, I watched Joe's expanding horizons with awe. When he retired in 2005, at age 77, he had been a Chicago professor for 45 years.

Joe Smith's Chicago colleague Robert Clayton described him as "an entrepreneur in the development of instruments". When Joe arrived in 1960, he devoted about four years, as a pioneer, to the building an electron microprobe for the Department of Geophysical Sciences, and in developing the techniques that made the machine work successfully. In the early 1960s there were many analysts who said that the electron probe would never yield quality results because there were just too many problems. The task was rather like making science fiction become fact. The Chicago department was one of the first to have a successful instrument, an instrument that is now ubiquitous in geology departments. Twenty years later, he devoted similar efforts to the ion microprobe. For establishment of the difficult analytical procedures he gave much credit to Ian Steele, Ian Hutcheon and Ron Draus.

From the mid-1980s, Joe became intensely involved with a second generation of synchrotrons that were built to optimize X-ray and infrared beams. In addition to participating in national planning for these advanced radiation sources, he was Principal Investigator for a programme at Brookhaven National Laboratory to set up a national facility for X-ray fluorescence analysis. When a high-energy source was assigned to Argonne National Laboratory, managed by the University of Chicago, he was asked (as the local expert) to build the facility at the Advanced Photon Source. In 1988, at 60 years of age, Joe somewhat reluctantly accepted this administrative load. He reported that this set him on a 12–16 hour day through the next five years before turning over the

facility to Keith Moffat, Mark Rivers, Steve Sutton, James Viccaro and Joy Talsma. But he did not neglect research. In 1989 he organized a multi-institutional, multidisciplinary group of scientists to use the Advanced Photon Source. CARS, the Consortium for Advanced Radiation Sources, developed into a productive activity spanning three sectors for the application of X-rays to: structural biology; chemistry and material sciences; and geo-soil-environmental sciences. CARS raised millions of dollars through 15 years. Joe was director until 1993. He noted that although this turned him effectively into a full-time businessman as he hunted for money, it also required that he read widely. He became increasingly concerned about the use of the world's limited resources for war rather than for humanity, and he became interested in the toxic elements that affect the health of so many people around the world. This influenced his research and writing from the 1990s. So, let us return to some aspects of his research development.

Joe started off as a crystallographer, and followed his structural interests into mineralogy. The early series of feldspar papers by Smith and MacKenzie guided Joe deeper into the details of this most important rock-forming mineral of the Earth's crust. He described Tom Barth as a genial host at the 1963 NATO Institute on Feldspars at Oslo, and blamed him for the inspiration to begin writing a treatise on feldspars. The task was facilitated in 1965 by preparation of a course on feldspars during a term visiting at the California Institute of Technology. I saw Joe at work on this treatise. He was a literature soak. He went on most Saturday mornings to the library armed with index cards and pen, and returned with a stack of notes. I had the impression that he checked every worth-while journal, gathering information on feldspars (and anything else that caught his fancy). He also copied and collected abstracts. Furthermore, he seemed to remember nearly everything that he collected on those cards. His encyclopedic knowledge and critical insight were well represented 10 years later when his treatise on *Feldspar Minerals* appeared in two volumes (Smith, 1974). One reviewer wrote that libraries should purchase two copies, because the first set would soon be worn out. A third volume was published in 1988 (Smith and Brown, 1988). These books identified Joe Smith as the world's feldspar authority.

Joe's textbook on *Geometrical and Structural Crystallography* (Smith, 1982) followed the

monumental feldspar monographs. The contents are very different from the crystallography that I enjoyed as an undergraduate and I cannot write about them with insight. The book cover comments: "...unique approach begins on a simple level with symmetry, packing and topology as a framework for subsequent study of crystal structure. Complicated mathematics and theorems are avoided in the early chapters. Point group symmetry and equivalent positions are developed early in the text, so that the shapes of crystals are explained on the basis of atom construction". There are more than 200 illustrations, and graded exercises divided into three levels planned to encourage the development of thinking in three dimensions. Joe's office and laboratory were full of three-dimensional models of crystal structures of real minerals and designer zeolites.

During the feldspar-production years, Joe began to work on the structures of zeolites as a consultant to the Linde Division of Union Carbide Corporation at Tonawanda, NY. He started consulting originally in 1956 to pay family fares for visits to England, and he fell into one of the great success stories of industrial chemistry. Zeolite molecular sieves have revolutionized catalysis, and this led him into quite a different world. Donald Breck and Edith Flanagan of Union Carbide guided Joe, and he described them as brilliant chemists ready to preserve the scientific integrity of his research. I understand that Joe designed possible zeolite structures and compositions, and they synthesized the minerals. Joe's role was to answer basic questions concerning how many zeolite frameworks were possible; how were structural frameworks of the existing zeolites assembled from sub-units, and could the pieces be assembled in other ways; was there a limit to the size of windows for the molecular sieves; how many atoms could be expected to go into the zeolite frameworks; where did the exchangeable cations reside in the crystal structures; and so on. This basic crystallographic research had huge societal impact. One synthetic zeolite became a commercial success as a component of washing powder that replaced the phosphorus compounds that promoted noxious algal blooms in rivers and lakes. Other zeolites replaced the old amorphous catalysts and tripled the yield of gasoline from oil. The world of molecular sieves is one in which major oil companies sue each other over patents on the use of zeolites as catalysts for cracking petroleum.

Joe Smith was called on as an expert witness in at least one of those suits. For their meticulous research on synthetic zeolites, Joe has expressed debts to his academic colleagues Gerry Gibbs, Joe Pluth and Michael Bennett.

While feldspars and zeolites were still perking away, the Apollo Program to land men on the moon and to return rock samples was steaming to a boil, and Joe could not resist the excitement. He became a principal investigator and extended his research to the origin of lunar rocks, which completed his transition from crystallographer through mineralogist to petrologist. Apollo 11 in July 1969 returned the first lunar rock samples to Earth. The results were presented in March 1970 at the first Lunar and Planetary Science Conference. Joe reported the first new mineral on the Moon, *pyroxferroite*, and presented a model for a hot Moon which contradicted the dominant, standard model that the Moon had remained cold during its formation. The hot Moon of Joe Smith and his Chicago team (of about nine colleagues) was given a somewhat frigid reception. Joe presented a model relating the mineralogy and petrology of the rocks to the differentiation of a very large body of magma, with feldspars rising to form the light-coloured highlands. He credited John Wood for a related interpretation of floating feldspars. Joe maintained that the Moon's surface must have been extensively melted in a series of catastrophic meteorite impacts. At a press conference afterwards, Harold Urey, the eminent former Chicago faculty member, stated that he could not imagine how someone from his Alma Mater dared to propose such a ridiculous scheme. The moon had accreted as a cold body, and the presence of lavas demonstrated only that some local events had temporarily caused minor heating. A decade later, magma oceans on both moon and Earth appeared to be accepted even by those who wrote in 1971: "this is not possible" and "entirely lacking in supporting evidence" and "encounters a fatal difficulty". What Joe did, in fact, was to look at the evidence, reach a conclusion, and state it, despite the fact that it ran counter to 1970 rules. A farm boy ploughs his own furrow. His co-authors were convinced. The lunar work expanded Joe's horizons to the origin of planets.

His research, his intensive extended reading, and his deliberations were well represented by his Hallimond Lecture for the Centenary of the Mineralogical Society of Great Britain, published as: *Mineralogy of the Planets: a Voyage in Space*

and Time (Smith, 1979). This began and ended with verses from Milton's *Paradise Lost*. He was saddened by developments in the Space Program after Apollo, writing in his acceptance of the Roebling Medal (Smith, 1983): On this happy occasion, "I will not pursue the present state of the space program which is increasingly bedeviled by the evil consequences of political and nationalistic rivalries".

The Apollo Program established a surplus of excellent analytical facilities for a small number of returned samples, and Joe joined other investigators in seeking ways to put the facilities to continued good use. Barry Dawson reminded me that I had put Joe in touch with him because he had a superb collection of rare African rocks. Joe visited Barry in St. Andrews in August 1971, returning with selected samples. Barry visited Chicago in April 1972, and returned for later visits that led to an incredibly productive series of joint papers dealing with analyses and interpretations of mantle nodules and other African beauties. Barry Dawson was one of the organizers of the First International Kimberlite Conference of 1973, when De Beers opened up several kimberlite mines for detailed, guided tours. Smith and Dawson presented three papers on intricate mineralogy. Joe was one of the many participants who had their eyes opened in the darkness of deep mines to the complexities of kimberlite magmas. Excellent field trips were organized, and I recall fragments of stimulating stories of Joe riding (or failing to ride?) a donkey (or was it a mule?) on the mountains of Lesotho. Joe thus graduated as a field geologist.

At that time, it was widely held that diamonds had precipitated from kimberlite magma, they were phenocrysts rather than xenocrysts. Diamonds had been found in a few eclogites derived from the mantle (some said 'crust'), and Vladimir Sobolev in 1969 had described a xenolith of pyrope-bearing serpentine containing diamond. Dawson and Smith were the first to identify diamond in a xenolith of garnet lherzolite, a rock that was recognized as a common upper-mantle rock. This was potentially an abundant source of rare xenocrystic diamond. It was probably this discovery that led to the general acceptance of the idea that most diamonds were just getting a ride on the kimberlite magma train as it shot through the crust.

Joe's lunar research had attracted him to the role of asteroid impacts in the origin of the moon, and their ancient and potential effects on Earth.

This topic became lively with the general acceptance in 1980 that events caused by the asteroid impact at Chicxulub were responsible for the dinosaurs' extinction. Then came the concept of the 'nuclear winter' that might follow a major nuclear exchange capable of killing up to 1 billion people in the first few days. Joe was strongly affected by these discussions, and became increasingly concerned about the state of the world and the dismal prospects for its future. During the 1980s he began to write, and make conference presentations, about natural hazards such as earthquakes, volcanoes and threats presented by Earth-colliding asteroids and comets. In 1983, he was asked by the American Geophysical Union to organize a session at the December meeting in San Francisco on 'The Geophysical Consequences of Nuclear Explosions'. As he read the preliminary reports, Joe found that he was becoming obsessed by mental images of burning cities and broken bodies. Then he was invited to present a paper on natural hazards at the 'Fourth International Seminar on Nuclear War' in the hill-top town of Erice in Sicily. This 1984 conference included representatives of the nuclear powers giving papers on military and diplomatic planning. Joe reported that the participants were psychologically incompatible.

In 1983, he wrote in the final paragraph from his acceptance of the Roebling Medal of the Mineralogical Society of America (Smith, 1983): "Let me finish with a hope for the future. Currently the forces of love and friendship seem to be weakening in the world in the face of scientifically-based technology misdirected by fear, hatred and greed. There is no simple choice for an individual scientist, and the easy out is to get on with research and hope for the best. I trust that this society and other ones will make a special effort to develop programs that will increase international cooperation in as many ways as possible. Just consider how research and teaching in mineralogy and other sciences could be improved around the world with just one percent of the money spent on war machines. This is a small goal which is not immediately relevant to the pressing problems of neutron bombs and cruise missiles. But in the long term, international ties between scientists can help to establish that we all belong to one human race, and must learn to live in peace on this planet". This concern for the future intensified through his years with synchrotron-based research.

In 1993, when Joe relinquished the directorship of CARS, he was relieved to return from administration to a professorial life of research and teaching. His science reflected his concerns about the future of the human race. In 1998 he organized a National Academy of Sciences Colloquium on 'Geology, Mineralogy, and Human Welfare'. His opening paper included reviews of emerging chemical microscopes that use neutrons, synchrotron X-rays, and electrons. These were revolutionizing the study of mineral surfaces, fluids and microbes and had many applications to agriculture and soils, trace elements and food quality, the hazards of toxic elements and asbestos, and the formation of ore deposits. Other contributions dealt with topics such as the consequence that as human society expands its dominion over Earth, using natural geological resources, it is increasingly threatened by the destructive power of volcanic eruptions, earthquakes, landslides, floods and storms. The natural geological processes become hazards.

Similar concerns were manifest in his teaching. The University of Chicago College required a 3-term sequence of science courses, general education for non-science students. This was known in the 1970s as 'Rocks and Stars'. In the late 1990s, Joe took on the third term and organized a course entitled 'Geology and Human Welfare'. This was designed to convey the links between Earth science and the human condition. Topics included industrial technology and Earth resources, volcanoes and earthquakes and their impacts, floods and landslides, atmospheric physics and chemistry, military affairs and geology, and ecology and ethics. The geology of the Chicago region included field trips. He felt fulfilled through the three years that he taught this course to intelligent students. Some of the themes covered in the National Academy Colloquium and in the teaching course were developed in a long review paper (Smith, 2000).

Starting in 1998, Joe published several papers on biochemical evolution, beginning with his old friends the feldspars and zeolites (Smith, 1998). His course 'Geology and Human Welfare' led him to ponder the reasons for human evolution in East Africa, which he discussed with Barry Dawson, his collaborative African expert (now at the University of Edinburgh). During four years of discussions, Barry came up with a correlation between fossil remains and the unusual carbonate volcanism in the Rift Valley, which could produce soils high in nutrients such as phos-

phorus. Joe related this to the importance of biological nutrients in a favourable environment for good health. They speculated whether volcanic trace elements might have been a propelling influence on hominid evolution by effecting gene mutation. Their joint manuscript has not been published, but Joe has a paper: *Geochemical Influences on Life's Origins and Evolution* (Smith, 2005). He noted that after the first living cells were generated by geochemistry on internal mineral surfaces, about 4 billion years ago, life evolved with utilization of energy from the sun and incorporation of selected elements. Then he drew on emerging evidence from metabolism, gene regulation and medicine and its possible relationship to geochemistry and an evolving large-brained primate population that happened to be in a good place during the right volcanic interlude.

After retirement Joe Smith was trying to complete his multi-dimensional, autobiographical book (Smith, 2007). Two quotations from that text provide his message to all of us:

"Even in 2006, most people are quite unaware of the ecological effects of their actions and the critical need for sustainability. Training in geology, astronomy and ecology, and thinking about the future should be a key feature of school, college and university curricula." "Let us leave a better world for our own grandchildren and every grandchild around the World."

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PETER. J. WYLLIE

Joseph Victor Smith
July 30, 1928 - April 6, 2007

Joe Smith was a man of many talents and interests. His study of the moon, his investigation of feldspars or his contribution to the electron microprobe: each of these achievements by itself would have earned him the respect of his scientific colleagues.

We remember Joe Smith mostly as a zeolite scientist and as a man who advanced the field in many ways. I would like to celebrate his accomplishments and remember his scientific life by reminding you of some of the best of his zeolite-related work. For more details of his vita and of his other interests see the obituaries on the [University of Chicago](#), the [Boston Globe](#) and the [Chicago Sun Times](#) websites.

Between 1929 and 1933 the crystal structures of zeolite minerals of the SOD, ANA, EDI, NAT and THO-types had been determined. It took more than 20 years before any further zeolite crystal structures were correctly solved: the CAN-type in 1955, LTA (the first synthetic zeolite) in 1956 and FAU and CHA in 1958. It is hardly imaginable today, but when Dent and Smith determined the structure of the CHA-type in 1958 it was a difficult undertaking, what with five crystallographically independent atoms! Wyart had attempted it in 1933, but his determination was wrong (he had obtained the SOD-type structure in rhombohedral setting instead). Following Dent and Smith, Nowacki and collaborators published an independent structure determination of the CHA-type in 1958 as well. This was the time when Barrer's work was beginning to bear fruit and various industrial applications of zeolites became a reality. It kindled the interest in the crystal structures of these strange compounds and was followed by a flurry of activity: numerous zeolite crystal structures were determined in the 1960's.

Twenty years later Joe was again at the forefront. By this time the

impact of computers on the practice of crystallography had revolutionized the field and allowed the determination of complicated structures such as silicalite. Both ZSM-5 and silicalite were known as extremely interesting materials of MFI topology. This topology was established in a February 1978 publication on silicalite in the journal *Nature* by Flanigen, Bennett, Smith and collaborators. In March of the same year the structural description of ZSM-5 by Kokotailo, Lawton, Olson and Meier was published. These were the most complicated crystal structures of zeolites determined so far. This work opened the way to much fruitful research in the coming years.

After the tetrahedral aluminophosphate molecular sieves were synthesized in the early 1980's it was again Joe Smith, who, together with Bennett, Flanigen, and Pluth led the way in exploring these new crystal structures. The first to be studied was the structure of AFI topology, to be followed by several more. Investigations of this group of compounds continue into the present.

But even when Joe was not the first to enter an area of study, he still could set the standard for the quality of workmanship. In five carefully performed experiments published from 1979 to 1983 Pluth and Smith showed how to refine the crystal structures of LTA-type compounds. They established that the so-called zero-coordinated cations claimed to occur there were the artifacts of faulty refinements.

However, Joe was never satisfied with experiments alone. He saw the potential of seeing things in their context. For example he followed the path indicated by A. F. Wells and studied the three-dimensional nets of bonds outlined by the T-O connections in zeolites. He began this work in 1964 with a paper by Moore and Smith, and he continued to explore this field systematically over the years. In 2000 Joe published a book in the Landolt-Börnstein series summarizing his exploits along those lines. In this book he analyzed the topological properties of numerous nets occurring in actual crystal structures, mostly in zeolites. This is an excerpt from his unpublished *Catalog of Theoretical Nets* comprising 1300 examples. His heroic and thoughtful work in this direction is now being superseded by computer-based approaches as pursued by

Mike Treacy and collaborators.

Because Joe liked to see the general case behind each specific instance he was very good at writing review articles. Rather early in his “zeolite-career” and at a time when many zeolite crystal structures were not known yet, he published in 1963 a Structural Classification of Zeolites. His “Topochemistry of Zeolites and Related Materials. 1. Topology and Geometry” of 1988 became an instant classic and has been cited almost 400 times. His voracious appetite for reading is documented by the 525 references given in that paper. I am not aware that he ever published the second part, which I assume would have been titled “Topochemistry of Zeolites and Related Materials. 2. Chemistry”. Somebody else will have to do that.

I estimate that about one quarter of his ca. 400 published papers deal in one way or another with zeolites. However many zeolitic papers he wrote, he always had a keen awareness of what was important and often his work defined what was to become important.

Incidentally, the photographs of Joe at two of the websites mentioned above show him the way we all have seen him often: he holds in his hands one of his numerous zeolite models. While we mourn his parting let us remember Joe the way he was: an enthusiastic scientist, always full of stimulating ideas. Let us remember him with one of the zeolite models in his hands.

Werner H. Baur
April 30, 2007

Presentation of the Roebling Medal of the Mineralogical Society of America for 1982 to Joseph V. Smith

PETER J. WYLLIE

*Department of the Geophysical Sciences
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Mr. President, Members of the Society, Guests:

If I had been given the chance to choose someone to introduce for the Roebling Medal, my selection would have been Joseph V. Smith. His creative research productivity identifies him clearly as a mineralogical medalist.

I will introduce him to you through his career. He claims that he is still the farm boy who grew up in Derbyshire. This always reminds me of the Illinois politician who claimed that he was a "simple country boy". When he died, the shoe-boxes discovered in his room contained millions of dollars. Joe Smith, the country boy from Derbyshire, will also leave a legacy, but it will be an intellectual and written legacy for all of us.

Between 1945 and 1951 in Cambridge, England, he earned degrees of B.A., and Ph.D. Between 1951 and 1956, as a Fellow at the Geophysical Laboratory, and then as a Demonstrator at Cambridge University, he soon gained attention with his publications on crystallography and mineralogy. I still remember the feldspar papers by Smith and MacKenzie that I had to read as I completed my honors degree. I first met Joe Smith in 1956, when I went to Penn State as a graduate student and he arrived as Assistant Professor. Joe went to Chicago in 1960, and enticed me there in 1965. I have seen his work at close quarters ever since.

I mentioned his productivity. He started normally in 1952, publishing 2-3 papers per year. By mid-1982, his publications exceeded 320, which is surely abnormal for so young a mineralogist. Quantity is accompanied by quality and diversity. We all see a lot of J. V. Smith publications, but probably we all see different ones, because he has so many research interests. I will pick out three of the continuing threads which run through his research.

He started off as a crystallographer, and followed his structural interests into mineralogy. He has a series of important papers dealing with major rock-forming minerals, and his encyclopedic knowledge and critical insight are well represented by his two volumes on FELDSPARS. One reviewer of those books wrote that libraries should purchase two copies, because the first set would soon be worn out.

Zeolites and feldspars are not too dissimilar, but zeolites are useful. Joe Smith began to work on the structures

of zeolites in 1956 as part of his association with Union Carbide. Zeolites led him into quite a different world, the world of molecular sieves, a world in which major oil companies sue each other over patents on the use of zeolites as catalysts for cracking petroleum. Joe Smith has been called upon as an expert witness in at least one of those suits.

The third thread became an expanding sheet of cloth. As principal investigator in the Apollo program, Joe Smith extended his research to the origin of lunar rocks, the origin of the moon, and hence to the origin of the universe. This work is represented by his Hallimond Lecture for the centenary of the Mineralogical Society of Great Britain, published in 1977 as a special reprint: "Mineralogy of the Planets: a Voyage in Space and Time".

Joe Smith has an agile mind, and he is not afraid of novel interpretations. At the First Lunar Science Conference, the hot moon of Joe Smith and his Chicago team received a somewhat frigid reception. When Joe presented a model involving differentiation of a very large body of magma, an eminent former Chicago faculty member stated at a Press Conference that he could not imagine how someone from his Alma Mater dared to propose such a ridiculous scheme; the moon was cold, and the presence of lavas demonstrated only that some local event had temporarily heated a small part of it. In recent years, magma oceans on both moon and earth appear to be accepted even by those who wrote in 1971: "this is not possible", "entirely lacking in supporting evidence", "encounters a fatal difficulty". What Joe did, in fact, was to look at the evidence, reach a conclusion, and state it, despite the fact that it ran counter to 1970 rules. A farm boy ploughs his own furrow. The lunar work completed the transition of Joe Smith from crystallographer through mineralogist to petrologist, and I wish I had the time to review his work on peridotite nodules, kimberlites, and their implications for mantle mineralogy and composition.

I have outlined a small sample of the research of Joe Smith. He is a fine example of how rewarding it can be to cross disciplines in order to get a new look at an old or familiar subject. He is also an example of a research scientist who can design and maintain instruments. The younger folk among you, who sit before the electron

microprobe and reap printed and recalculated analyses, probably do not realize that in the early 1960s there were many analysts who said the electron probe would never yield quality results; there were just too many problems. Joe Smith devoted about four years of his life to developing the techniques which made the machine work so successfully. I anticipate similar success for his current efforts with the ion probe.

I do not know how Joe's upbringing on a farm contributed to his agile mind, but I do know how it contributed to his fine pair of experimental hands. Many of us have seen Joe sitting on a chair, manipulating the buttons on the electron microprobe. It you catch him in a relaxed moment, he may explain to you that he is one of the few crystallographers who can obtain satisfaction from sitting on a stool and milking a cow, the old-fashioned way. If

you catch him in a really relaxed moment, he may even offer to demonstrate.

There are many other topics I should mention. When Joe received the Murchison Medal a couple of years ago, some interesting stories surfaced which bear repetition—but unfortunately there is not enough time.

I should have referred to Joe's recent textbook on "Crystallography", which makes excellent reading. Instead, I will refer to Brenda, his friendly wife and companion. After bringing up a family, she now writes novels while Joe writes science. She has two manuscripts which may make their way into books. I shall look forward to reading them, and I know Brenda well enough to know that I can recommend them to you.

Mr. President, I am delighted to be the one privileged to present Joe Smith for the Roebling Medal, 1982.

Acceptance of the Roebling Medal of the Mineralogical Society of America for 1982

JOSEPH V. SMITH

*Louis Block Professor of Physical Sciences
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The University of Chicago, Chicago, Illinois 60637*

President Lindsley, Fellows, members and guests:

I am deeply grateful for the award of the Roebling Medal. Peter Wyllie was extremely generous, and I must temper his remarks by emphasizing the advantages that came my way in this *Golden Age of Mineralogy*.

I was fortunate to learn by instinct on my father's working farm how complex and fragile is the cycle of life. My mother and an uncle were teachers, and they encouraged me to win a scholarship to an academic high school. The physics and chemistry teachers were busy teaching regular classes. As the only science student at the advanced level, I was excused from all classes to study for the entrance scholarship exam of Cambridge University. Working through 30 years of earlier exams proved to be an excellent training in problem-solving and research. This probably explains why I am impatient with students who require spoon-feeding.

The present state of science teaching in the USA is a matter of concern: for example, there are only 22 chemistry teachers in the public high schools of Chicago. What does this portend for the future? What steps are needed to provide a training like the one I profited from?

I slipped through the gap between World War II and the Korean War. The teaching at Cambridge University was superb, and totally supported by government scholarships and a rich endowment. I specialized at first in nuclear and solid-state physics. It was fortunate that high-energy physics was collapsing at Cambridge, and I chose crystallography for a Ph.D. Helen Megaw, William Cochran and William Taylor ran a marvelous operation. However, I was assigned to work on calcium carbonate silicate minerals, and found the computations so tedious that I almost quit to go into industry.

Perhaps my greatest good fortune was to receive a Fellowship at The Geophysical Laboratory, and not be appointed to the Cambridge faculty. The Geophysical Laboratory was rather primitive in those days, and I built an X-ray generator in the doghouse from junk equipment and chicken wire—you can see how important was my training in farming. William Scott MacKenzie, Frank Tuttle and Hat Yoder started to educate me in Earth Sciences, but I was still as green as grass. Geology was baffling even when expounded by Mac or Felix Chayes. But Mac got me going on feldspars, and I knew that I must learn petrology and geology.

Back in Cambridge, but now in mineralogy and petrology,



I was given special tuition by Stuart Agrell and Henry Emeleus in the British Tertiary Province: but I was chastened by the complexities of feldspars in granites.

Cambridge froze faculty tenure, and four years at Penn State in the days of the white coat brigade extended my education under Frank Tuttle, Elburt Osborn and others. I began to consult with the Linde Division of Union Carbide Corporation to pay for travel to Britain, and fell into one of the great success stories of industrial chemistry. Zeolite molecular sieves have revolutionized catalysis, and I have been guided by two brilliant chemists: Donald Breck (+ 1980) and Edith Flanigen. Collaboration between industry and university is not easy, but Don and Edith always went out of their way to preserve the scientific integrity of my research. I am particularly indebted to Joseph Pluth and Michael Bennett for their meticulous research, which is now expanding into several new directions. Gerry Gibbs has taken off like a shooting star since our early collaboration.

For years I had admired the work of Julian Goldsmith and Fritz Laves, and could not resist the call to Chicago. Julian's concept of a small, unified Department of Earth Sciences has proven highly successful, and my education continues daily from the other faculty members. Hat

Yoder will remember the thrill when his pyroxenes checked out the viability of the electron probe. Seems trivial now, but not then. The sun shone 24 hours a day at the NATO Institute on Feldspars at Oslo in 1963. Tom Barth was a genial host, and he inspired me to begin writing a treatise on feldspars. But these carefree days were passing as new responsibilities were assumed, and the forces of fear and destruction began to build up again in the world.

The politically-motivated Apollo landing on the Moon led to the initial euphoria associated with the discovery of new rocks and minerals. In ten years we have made marvelous discoveries about the planets, and have learned how to use diverse cosmochemical and cosmo-physical data to infer the origin of the Earth. This is a happy occasion today, and I will not pursue the present state of the space program which is increasingly bedeviled by the evil consequences of political and nationalistic rivalries.

The ion microprobe is now a proven instrument but the establishment of analytical procedures was and is difficult: Ian Steele has done a great job. Our original instrument has been largely rebuilt to mitigate design and construction faults, and I am particularly indebted to Ian Hutcheon and Ron Draus.

The Roebling Medal, of course, is based on past research, and I must confess to a bittersweet feeling at its award to me. Every year there is an increasing number of fascinating problems, and the Roebling Medal signals that many years have gone, and that those to come are numbered. Hence, I am delighted that my colleagues have been so successful this summer. Ian Steele has used the ion probe to measure trace elements in the Keith-Tuttle samples of quartz. Aluminum correlates with the inversion temperature. We can anticipate that a trace-element signature will reveal the provenance of quartz grains in sandstones: Archean sediments should prove particularly interesting.

Joe Pluth has demonstrated aluminum and phospho-

rous ordering in structure type 81 of a new family aluminophosphate molecular sieves. We are itching to go cracking with the synchrotron and pulsed-neutron sources.

Richard Exley has demonstrated that the initial strontium ratio can be determined for calcites with the ion probe, and we anticipate important applications to carbonates and Archean marbles.

Adrian Jones has obtained petrological information on the granulite lower crust of Tanzania, and has developed microprobe techniques for accurate measurement of hydrogen and fluorine in micas.

In the field of meteorites, the enstatite chondrites are proving to be very complex, and we expect to obtain critical data on the formation of chondrules in the early days of the solar system. Just last week, Ian Steele and I showed that an Antarctic achondrite had been cooked in a vapor rich in sulfur and potassium.

Let me finish with a hope for the future. Currently the forces of love and friendship seem to be weakening in the world in the face of scientifically-based technology misdirected by fear, hatred and greed. There is no simple choice for an individual scientist, and the easy out is to get on with research and hope for the best. I trust that this society and other ones will make a special effort to develop programs that will increase international cooperation in as many ways as possible. Just consider how research and teaching in mineralogy and other sciences could be improved around the world with just one percent of the money spent on war machines. This is a small goal which is not immediately relevant to the pressing problems of neutron bombs and cruise missiles. But in the long term international ties between scientists can help to establish that we all belong to one human race, and must learn to live in peace on this planet.

Mr. President, my wife and children have been an essential support to my life and work. I dedicate this Roebling Medal to them, and hope that this *Golden Age of Mineralogy* will continue to shine.

Tribute to Joe Smith by Barry Dawson

St Mary's Church, Crich, Derbyshire

23rd June 2007

You in Joe's family and close family friends are well acquainted with his personal side, his virtues and foibles, but it is perhaps your very closeness to him that makes it difficult for you to view your Joe as a major international scientist. Today I would just like to mention some of the things that, in my perhaps more-detached view, have made him so much appreciated by scientists worldwide.

Joe was brimming with energy, he was a man high intellect and full of insatiable curiosity, a wonderful cocktail of attributes in any man but particularly so in a scientist – particularly the curiosity. This combination resulted in him being a prolific researcher, having published over 400 papers and three definitive books, to his being recognised as the world authority on two major groups of mineral, and to being honoured by the highest scientific societies in Britain and the United States of America.

He was also a man of incredible precision, a point that came home to me when we were on a field trip in South Africa; we were staying in a hotel in Kimberley where we were looking at diamond deposits. One night some of the group, probably well fuelled by good South African wine, went on partying noisily well into the night. At breakfast next morning I casually said to Joe "I wonder what time that party finished last night?" Joe's answer was immediate and precise – "It was 12 minutes past 3!" I had surmised that it was late but Joe knew to very minute! Precision and tidiness of mind were things that characterised Joe and made him a superb organiser. Scientists are generally very individual and egotistical creatures and getting them to agree on anything is a bit like herding cats, so perhaps Joe's major organisational triumph was the

managing of a disparate group of scientists to use a very expensive (several billion dollars) facility at the Argonne National Laboratory near Chicago; in 1988 Joe pulled together these scientists from many different universities and different scientific disciplines – material scientists, geologists, chemists and biologists - to form The Consortium for Advanced Radiation Sources. Joe initiated the consortium and managed it for several years. The fact that the consortium is still running successfully some 30 years later is a vindication of Joe's personal motto that "Organisation is the Key to Success".

I am sure that most of you will know the general gist of that famous poem by Thomas Gray - "The Elegy Written a Country Churchyard" in which after wandering among the grave stones in the churchyard in the little village of Stoke Poges, he lamented what he regarded as the waste of latent talent due to the lack of opportunity for the inhabitants of that little rustic community. If he had been able to meet him, I wonder what Thomas Gray would have made of Joe? On the one hand he should have been glad that a man from a quiet country setting had been able to emerge as a major international scientist, that someone from this background had broken the mould; on the other hand he may have been irritated that his poetic apple-cart had been upset and that someone had successfully challenged his melancholy assumption that people from a rural background were destined for obscurity

Joe was very good at challenging assumptions, though not through any desire to be awkward but through sheer curiosity. He would sometimes ask "So and so says this, that and the other. Can that really be correct"? And then he would go and sift the evidence, produce new facts if necessary, and then come up with an alternative and usually-right answer. Perhaps the best example of this was when Joe became a Principle Investigator in the American Space Programme to examine rocks brought back from the moon after the Apollo landing. The origin of the moon had always perplexed the most inquisitive minds at any time in history – going back to Galileo and Keppler - and, at the time of the moon landing, the current theory was that the Moon had

always been a cold planet. After researching the rocks, Joe came up with a completely new theory – that the white parts of the moon were caused by white crystals that floated to the surface when the infant moon was hot and molten, and that the round black areas were caused by the emergence of black lava welling up the surface through holes punched through the crust by the impact of meteorites. His new theory caused a furore at the time but it is now universally accepted.

In my opinion this was his finest hour. So I leave you with this thought. Next time you look up at the Moon, may it remind you of that remarkable man Joe Smith who made one of the finest scientific achievements of our time by solving the problem of origin of the moon.

Eulogy for Joseph V. Smith

Virginia A. Smith

St. Mary's Church, Crich, Derbyshire
4 p.m. June 23, 2007

Thank you all for coming. Your presence is a wonderful tribute to my father.

For my father, there was no better place in the world to have been born than on a dairy farm near the cradle of the Industrial Revolution, in the beautiful rolling countryside of the Pennines, among the revolutionary 18th century factories, the canals, the newly invented machinery, and millers cottages of nearby Cromford. These two things—farming, and his fascination with the innovations of the integrated factory system--gave birth to his two passions: a love of nature, especially its rocks and minerals, and a drive to use science to improve the lives of humankind.

Joe's parents, Henry Smith and Edith Robinson, inculcated in him the value of hard work and the need to keep the land "in good heart." On his boyhood farm, Barn Close in Fritchley, he learned the rhythms of the seasons and the need for long, work-filled days. Cows had to be milked twice a day, and there were always calves to feed, eggs to collect, fields to plough, seeds to sow, grass to scythe, hay to get in, crops to weed, walls to build, barns to muck out.

My dad wasn't a big story-teller—the Smith family had Henry and Tom for that—but if he were in an expansive mood, he'd tell you about milking the cows by hand on cold, dark, winter mornings, when he would snuggle up to the cows for warmth, and of studying at night by lantern-light, one hand holding a book, the other turning the handle on the butter churn. He told us about taking the milk to the Ambergate railway station with his father and the horse and trap, and of how, when he was four, he became lost in a hayfield, and many hours later, was found asleep under a haystack. He made little water wheels in a stream in Holly Wood near Barn Close with his brother Tom, who later became a carpenter, and every December, at his mother's request, he would climb a holly tree and cut off the top for their Christmas tree. He loved the abundant Victoria plums in the garden at Barn Close Farm, and the quiet joy of walking behind the plough pulled by the horse, Dolly. It was as a boy on Barn Close Farm that he first wondered why the moon had dark and light patches, and it was as a scientist working for NASA thirty years later that he developed a theory of the origin of the moon.

Against his father's wishes, but with the encouragement of his mother, and his aunt and uncle, Dora and Bill Leese, he pursued a scholarship to Cambridge

University, learning Latin in six weeks to take the entrance exam, and graduating with first class honors.

At Cambridge, he was referred to as “that brash young man.” Probably part of this supposed brashness was being seen as a lad from the North, and a “son of toil,” or “ton of soil,” as my mother says, among the pampered, wealthy, upperclass “toffs.” But probably part of it was that he was “a young man in a hurry.” There were things he wanted to do in life, and he couldn’t see wasting precious time while other people dithered. As he had learned to do as a boy on the farm, he got on with things with, as he said, “no messin’.”

But although he gained a veneer of sophistication at Cambridge, he was still wet behind the ears. When he was nineteen, he visited his auntie Elsie in London. He was presented with a record player and asked what he’d like to listen to. He scanned the records, never having heard of the composers, orchestras, and bands, and chose the only one he recognized. It was “The Teddy Bears’ Picnic.”

He pursued—literally—and then married Brenda Wallis, of Fritchley, whom he met when he was nineteen on holiday from Cambridge. He’d seen her working as a librarian at the Belper Library. True to form, he was too shy to ask her out, but instead tried to strike up a “natural” conversation. He knew she bicycled to wherever her home was, so he staked out various routes out of Belper. My mother, bicycling along the A6 towards Ambergate, caught sight of him out of the corner of her eye where he was skulking in a quarry, and the first time, ditched him by going an alternate route up the Bottom Hag, and the second time, ignored him while he chased her, his knees going up and down as he pedaled furiously. When he finally was able to follow her home successfully, he was astounded to learn that she was Brenda Wallis of Fritchley, with whom he been at the Fritchley C of E Infants School. And, as it happened, she had had her eye on him, too, and had considered him, at age eight, a “likely lad.”

Brenda and Joe married on August 31st, 1951, here at St. Mary’s Church, Crich, where Joe had been christened and where he attended church every week with his family, sitting in that pew right over there. After a honeymoon in Cornwall, Brenda and Joe were to sail to America on the Queen Mary. One of the hymns his mother chose for his wedding was “For Those in Peril on the Sea.”

Joe and Brenda spent 54 or their 56 years together living in America, first in Washington, D.C., then in Pennsylvania, and finally in Chicago, where Joe was a professor at the University of Chicago for 45 years. But every summer, he made sure to bring his family back to Crich, so we could spend time with our family. Despite his years as a professor in America, he always thought of himself as a farmer’s boy from Fritchley.

My dad was not a cuddly sort of person; he showed his love in tangible ways. On holiday in Derbyshire, he always helped with haymaking on Birchwood Farm, and by picking fruit, digging, and weeding in his parents' garden.

Whenever he visited me or my sister, he was a blur of energy, painting, knocking together bookcases, weeding, digging over garden, tiling bathrooms. The summer of 1985, after his father had his first stroke, Joe dug and planted his entire garden for him. I remember my grandfather standing by the window in the lounge at Green Acres, tears streaming down his face as he watched his son do what he was no longer able to.

Everyone here knows what a relentlessly optimistic person Joe was. For him, mistakes were not grievous errors they are for most people; they were wonderful opportunities to learn or see something new. I can still see him clapping his hands together when something took an unexpected turn, saying delightedly, "This is marvelous," with a big smile on his face. And indeed, most of the time, it was.

One weekend, he came to visit me when I lived in New York City. He had hired a car to take me on a trip out of town. He thought a walk in a state park would be just the ticket for his New Yorker daughter.

He took out a map, and randomly picked a state park in New Jersey, across the Hudson River from the Upper West Side of Manhattan, where I lived. He started driving, using the sun and what he thought of as his own impeccable directional ability to guide him. We got on the Henry Hudson, driving what I knew to be north (it should be noted here that New Jersey is primarily *west* of New York City).

The major bridge leading to New Jersey, the George Washington, passed by on our left. Then the Tappansee Bridge, the last exit to New Jersey. But my dad seemed to have things well in hand, and I was enjoying the drive, so I didn't say anything, not that he would have listened, anyway. An hour later, we were still driving. My dad started talking about the deficiencies of the map: the state park wasn't where it should have been; clearly, a crazed mapmaker had been deliberately trying to fool us.

Finally my dad turned off the highway, and we drove on some back roads, hoping to come across a park—any park. Of course, he wouldn't ask for directions, even though I suggested that we stop at a gas station, and that I would be the one to ask.

The backroads became more and more narrow, and less and less well-traveled. Finally, the road became deeply pitted with potholes, and we dead-ended into a trailer park.

"Dad," I finally said. "I don't think this is right."

My dad looked a little chagrined. We hadn't reached a state park in New Jersey; we were in a trailer park in a completely different state. This would be rather like heading out for a lovely walk in Monsal Dale in the Peak District, and ending up in Birmingham.

But my dad pulled himself together quickly. "Wasn't that marvelous," he later recounted to my mother. "We saw a new part of the country!"

"A trailer park in Connecticut," I later clarified to my mother, out of my father's hearing. I didn't want to spoil his fun. And, it had indeed been marvelous!

In that last, terrible year, I came to know my dad as I had never before. I have never witnessed such stoicism in the face of so much suffering. If the measure of a man is how he behaves in his darkest hours, Joe was truly inspiring in his unflinching bravery and appreciation of all that was being done for him. As I'd leave his hospital room at night, he'd always say, "Thanks for coming."

On his last night on Earth, my mother and I stayed with him in his hospital room, as we had the previous night. I'd asked the hospital staff to find his roommate another room, so we had it to ourselves. I pushed the other bed next to my father's bed, so my mother could lie next to him and hold his hand, and I lay on a cot the nurse had brought in.

We had kept the blinds on the windows up, and around midnight, I looked out the window and saw the hospital's tall steam chimney, high in the night sky, reminding me so much of the chimney of Masson Mill in Cromford. An enormous full moon with its black and white patches that my dad had wondered about as a farm boy on Barn Close farm floated directly over the chimney, and the steam from the chimney created ripples in the face of the moon. I thought then of my father's wonderful, generous spirit rising through the night sky, past all the workings of humankind, towards the moon, and of his life's work, his passion to understand the origins of our planet Earth and to protect the natural world, and his equal passion to use scientific achievement to better the lives of humankind.

Our "farmer's boy" died in the early morning hours of Good Friday, holding my mother's hand, the dearest thing to him in life.

And now he is once again back in the heart of his family and his dearest friends, returned home to Crich.



Joe ploughing on Birchwood Farm, 1969.



Joe on the haycart, Birchwood Farm.

AUTOBIOGRAPHY OF JOSEPH V. SMITH

PROFESSOR JOSEPH V. SMITH was Louis Block Professor of Physical Sciences and Coordinator of Scientific Programs for CARS, the Center for Advanced Radiation Sources, based in the Department of Geophysical Sciences of the University of Chicago, where he taught and conducted research during 1960-2003.

He is best known for research in zeolite molecular sieves and for working on meteorites related to the origin and geological evolution of the planets and satellites of the solar system. He has always been interested in safety both of individuals and of the species, and in 2007 is getting ready to publish “Living Safely” which puts together all the ways to live more safely.

He was educated at Cambridge University, England, 1945-51, where he received First Class Honours in the Natural Science Tripos in 1948 with emphasis on physics, chemistry, mathematics, and earth sciences. He received a Ph.D. at age twenty-three for the X-ray diffraction crystal structure of tilleyite, a calcium carbonate silicate mineral identified by Prof Cecil Tilley and Stuart Agrell from a carbonate-silicate contact in N. Ireland.

Before teaching and research at the University of Chicago 1960-200, he was a Fellow of the Carnegie Institution of Washington at the Geophysical Laboratory 1951-4, Instructor at Cambridge University 1954-6, and an Assistant then Associate Professor at State College, Pennsylvania 1956-60.

He consulted for Union Carbide Corporation (Linde Division at Tonawanda NY) then with UOP at Des Plaines IL from 1958-1988 and with other chemical companies on the zeolite molecular sieves that revolutionized the yield of gasoline from oil and provided phosphate-free detergents that brought about the clean-up of lakes.

In 1965, he began to work with NASA scientists, analyzing the composition and mineralogy of rocks and minerals from iron and chondritic meteorites in preparation for the Apollo 11 mission to the moon. He discovered the first new lunar mineral, *pyroxferroite*, in a basalt fragment from the moon.

Through the Apollo development program, he developed a model of a close-in “hot moon” dominated by Ca-Fe pyroxenes in a strong gradient enforced by the Earth’s gravitation that has gained increasing support over the cooler models. For geologists he has written about the theory of collisions between the Earth and moon with comets and asteroids that applies to the replacement of the dinosaurs by mammals.

Joe Smith advanced the use of the electron microprobe in the 1960’s to get chemical analyses of mineral slices and small fragments with an accuracy of 2 to 10%. This

revolutionized the chemical-optical study of fine-grained materials and was the key to sorting out the breccias from meteorites and the Moon. He published a series of papers comparing electron microprobe analyses of major and minor elements in reference bulk samples by conventional wet chemical techniques finding excellent agreement for some elements in some samples. Discrepancies were explained mainly by incorrect impurities.

His principal experimental research since 1985 was related to development of a microprobe for X-ray fluorescence analysis on the NSLS 3.5 GeV synchrotron at Brookhaven National Laboratory which is achieving a detection level down to 10-50 parts per million for a 20-100 micron spot.

In 1987 he was asked by the University of Chicago to develop microprobe facilities at Argonne National Laboratory and with the assistance of scientist administrators from both labs was able to assemble a national-international 3-sector \$100 million national facility at Center for Advanced Radiation Source (CARS) at the 7 GeV synchrotron –the Advanced Photon Source.

His principal research has been on feldspar and other framework materials for which he produced a book co-written with W. L. Brown, *Feldspar Minerals*, vols 1 and 2 in 1988 which is a revision of *Feldspar Minerals* 2 vols. His *Geometrical and Structural Crystallography* was published by John Wiley and Sons. He has written 433 scientific articles published in journals including *Science*, *Scientific American*, .

He has been given science's highest awards, Member of the American Academy of Sciences and Fellow of the Royal Society of London, and is the youngest winner of the Roebling Medal of the Mineralogical Society of America..

He is married to the former Brenda Florence Wallis and has two daughters and four grandchildren. After almost fifty years in Hyde Park, Chicago, and twenty-five years in Beverley Shores IN, he now lives in Brookline, Massachusetts just across the street from his elder daughter.

Joe and Poetry

Brenda F. Smith

Other writers have talked of Joe's work with feldspars and zeolites, of rocks from the moon, from Kenya, Australia and South Africa. Perhaps you have been told of the research institute he designed and brought to fruition for the Argonne National Laboratory and the University of Chicago. But no one has told you of his interest in poetry.

Joe read poetry often, as is evidenced by the number of books of verse we have on our shelves. They are not all mine by any means. Several times Joe organized a "poetry evening" at our home in Indiana, where members of our play reading group would gather for dinner and, afterwards, for a change of pace, would read aloud their favorite poems. Joe's choice was often Shakespeare.

And, when he was scheduled to lead a class of undergraduate, non-science majors, most of whom were taking a science class much against their will, he resorted to poetry to spark their interest.

It is surprising how many poets wrote what might be called scientific poems. John Updike, for example, and W.H. Auden, who was known as "the geologist's poet and was one Joe chose to use in his class. Auden's "In Praise of Limestone" begins:

If it form the one landscape that we, the inconstant ones,
Are consistently homesick for, this is chiefly
Because it dissolves in water. Mark these rounded slopes
With their surface fragrance of thyme and, beneath
A secret system of caves and conduits; . . .

At the end of the poem, when Auden is talking about his thoughts on life after death, he writes:

When I try to imagine a
Faultless love
Or the life to come, what I hear is
The murmur
Of underground streams, what I see is
A limestone landscape.

Another poem of Auden's that describes the role of weathering in changing a landscape, laments:

It is horrible to think what peaks come down to,
That pecking rain and squelching
glacier defeat
Tall pomps of stone where goddesses
Lay sleeping.

The students lapped this up. "Boring old science" wasn't as boring as they had thought!

Joe liked all poetry, but especially poems that spoke to his interests and his life. One that became a favorite, especially in his later years, was Robert Frost's "The Road Not Taken," which begins:

Two roads diverged in a yellow wood
And sorry I could not travel both
And be one traveller, long I stood
And looked down one as far as I could
To where it bent in the undergrowth

Then took the other as just as fair. . .

The poem ends:

I shall be telling this with a sigh
Somewhere ages and ages hence:
Two roads diverged in a wood, and I—
I took the one less travelled by
And that has made all the difference.

Like all of us, Joe had many such dilemmas in his life. The first major one was his decision that, should he not be successful in the entrance exam to Cambridge, then he would stay on the farm, as his father wished. A very young man's decision! I think he always regretted that an academic career and a farming one could not be combined. On meeting new people he would usually tell them that he was "a farmer's boy," and I know that, at the back of his mind he remembered Frost's words, earlier in the poem, when he says of the two roads:

Both that morning equally lay
In leaves no step had trodden black.
Oh, I kept the first for another day!
Yet knowing how way leads on to way
I doubted I should ever come back.

After this first divergence of paths, as in everyone's life there were others. When he

graduated from Cambridge, Joe contemplated first of all going into the army, and then emigrating to Australia as others of his family had done in his father's generation. An offer came from a university in Uruguay, of all places, with a salary of a thousand dollars a year, an unbelievable sum in 1951. He also explored other jobs, even one at Cadbury's factory in York where he would be working on the "crystal structure of chocolate." But, in the end, he joined what was called The Brain Drain to America, first to Washington and the Geophysical Laboratory, then back to Cambridge, afterwards to State College, in Pennsylvania, and finally to Chicago where he spent the last forty-five years of his career.

Joe was a practical man and, I believe, never regretted the decisions he made. He never wanted to join in my game of "What if?" What if we had gone to Uruguay? The children would be speaking Spanish! No, you make your decision and go on from there, Joe would tell me. This practicality stood him in good stead when he was faced with his last illnesses. Then he was braver than anyone I have known, and I am glad he had poetry as a solace.



Joe and Brenda on Herring Cove Beach, Cape Cod.

Memories of My Beloved Father, Joseph V. Smith

(Some passages also appear in the Eulogy)

“The glass is rising and we hope for a better week.”

--Joe's mother Edith Smith in a letter to Joe and Brenda in Washington, D.C.
Early Summer, 1952

Virginia A. Smith

I recently came across a letter written by my Granny Smith in the early summer of 1952 to Joe and Brenda, who were then living in Washington, D.C.

“I have two of your letters to answer this week as yours arrived this morning. Thanks for the snaps. I don't think Joe looks unduly serious. It is his natural expression . . . (!)

We have had almost continuous drizzle & showers this week, and everything is covered with sticky mud, which tramps into the house everywhere.

We have had a number of cows and one heifer calve, mostly bull calves but not all, & so we have now more milk. But we are feeding them with cabbage & our straw as we have had no grass grow this last summer. The aftermath was so short too that the cows cleared each field in a very short time. Now it is too wet to get the wheat in but the glass is rising & we hope for a better week.

We went to look over two farms on Thursday & I never had seen two such ruins. Daylight shone through one house in several places where it shouldn't, & both were fastened together by bands everywhere. Neither has electricity & one fetched drinking water from a spring in the field. I could hardly believe it, & my old ruin looks like a palace today, in contrast.

I am sorry to have more bad news for you, but Tom is in the Infirmary again with a broken jaw this time. He did it at work when a piece of wood caught him. This certainly seems to be his unlucky year . . . “

Here is privation and the hard, subsistence of farmlife, as recently as the middle of the last century: staying up all night with calving cows, months where there was nothing to feed the cattle but cabbage and straw, continual rain that made the fields too wet for planting, a potential new farm with no electricity or water, a son badly injured.

But what you also see is the unrelenting optimism that was my grandparents' and my father's watchword: ". . . the glass is rising and we hope for a better week." It was this sense that if you just keep putting one food in front of the other, and do what needs to be done, the glass will surely rise. It is this attitude that carried my father through his life and probably, more than anything else, made him the man he was.

"Derbyshire, My Derbyshire"

For my father, there was no better place in the world to have been born than on a dairy farm near the cradle of the Industrial Revolution, in the beautiful rolling countryside of the Pennines, among the revolutionary 18th century factories, the canals, the newly invented machinery, and millers cottages of nearby Cromford. These two things—farming, and his fascination with the innovations of the integrated factory system—gave birth to his two passions: a love of nature, especially its rocks and minerals, and a drive to use science to improve the lives of humankind.

Joe's parents, Henry Smith and Edith Robinson, inculcated in him the value of hard work and the need to keep the land "in good heart." On his boyhood farm, Barn Close in Fritchley, he learned the rhythms of the seasons and the need for long, work-filled days. Cows had to be milked twice a day, and there were always calves to feed, eggs to collect, fields to plough, seeds to sow, grass to scythe, hay to get in, crops to weed, walls to build, barns to muck out.

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Cambridge, His Shangri-La

Against his father's wishes, but with the encouragement of his mother, and his aunt and uncle, Dora and Bill Leese, he pursued a scholarship to Cambridge University, learning Latin in six weeks to take the entrance exam, and graduating with first class honors.

At Cambridge, he was referred to as "that brash young man." Probably part of this supposed brashness was being seen as a lad from the North, and a "son of toil," or "ton of soil," as my mother says, among the pampered, wealthy, upperclass "toffs." But probably part of it was that he was "a young man in a hurry." There were things he wanted to do in life, and he couldn't see wasting precious time while other people dithered. As he had learned to do as a boy on the farm, he got on with things with, as he said, "no messin'."

He enjoyed Cambridge immensely, learned a great deal, and made some life-long friends. He played poker one night a week, and, twenty years later, on a family visit to Cambridge, he showed Brenda, Susan, and me the indentations in the wall surrounding Caius courtyard where he and previous generations of curfew-defying students had clambered over the wall to return to their rooms. He was the cox of the Caius rowing eight. It was a tradition at the end of the race to dump the cox into the Cam, but as his teammates liked him, they tossed a less-liked teammate in instead.

But although he gained a veneer of sophistication at Cambridge, he was still wet behind the ears. When he was nineteen, he visited his auntie Elsie in London. He was presented with a record player and asked what he'd like to listen to. He scanned the records, never having heard of the composers, orchestras, and bands, and chose the only one he recognized. It was "The Teddy Bears' Picnic."

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Land of Opportunity

Joe was always very grateful for what America provided to him: a tremendous opportunity to do science that just wasn't possible in post-war England, when the best jobs went rightfully to those older men who had fought in the war. As my mother so memorably said, my father, upon graduating from Cambridge with a Ph.D. at age twenty-two, had several options: a job in Uruguay, working for Cadbury's in York on the "crystal structure of chocolate," or a bright future in America doing leading edge science. My dad joined the Brain Drain, and my mother happily went along for the ride. There were things she wanted to do with her life, and as she often said, "Thank God for Joe Smith" for giving her the life she so enjoyed, replete with travel around the world to conferences and field trips, Thursday nights at their beloved Chicago Symphony Orchestra, trips to museums, the theatre, and art galleries, and a beautiful house in Beverly Shores, Indiana, on the dunes overlooking Lake Michigan, where they lived, gardened, and entertained their friends from around the world.

A Father Like No Other

My dad wasn't like other fathers. For one thing, we didn't really know what he did, only that he worked with huge machines with odd names like "ion microprobe," though of course I thought it was something to do with iron. And for another thing, he worked much harder and many longer hours than did the fathers of my friends, who were no slouches themselves, as some of them were Nobel Prize winners.

For most of our childhood, my dad would leave the house by 7:30 a.m., work all day, come home at 6:00 p.m. for a quick dinner, then go back to his office until 10 or 11. He would often go to work on Saturdays, too. On Sunday afternoons, he was ours, and we would often go to the Point—a promontory jutting into Lake Michigan--to play catch, or to the Forest Preserves or the Indiana Dunes for walks.

My dad wasn't an expressive man. He was uncomfortable with chit-chat and emotions and didn't always know what his wife and daughters were on about. Put him with a group of geologists, and he could talk science all day, but put him in a social situation, and he didn't always know what to say. He was such a hard-charger that few people realized a central aspect of his being: he was very shy and spent a lot of time in his head, or doing his beloved reading, and was usually about two paragraphs behind the general conversation that was going on about him. But he had ideas. Did he ever have ideas!

Ever since I left home for college, I've been in the habit of calling my parents for a chat around teatime on Sunday afternoon. It usually consisted of a few sentences with my dad before he would say, "I'll go find your mother."

One Sunday in August about fifteen years ago, I made my usual call, and my mother picked up. We chatted for a bit about our week, then I said, “What’s Dad doing?”

“He’s on the deck with a stack of 3” x 5” cards, thinking up ideas,” my mother said.

I had to laugh. That was Dad to a T. On Sunday afternoons, most of the fathers I knew would be having a beer, watching sports on TV, or just sleeping. My dad was out with a stack of cards and a pencil, thinking up ideas.

Walks with Dad: Bulls, Bogs, and Barbed Wire

I lived for the summers, when we went back to England for three months almost every year of my childhood. That was when we saw my dad more than just in passing.

In the mornings, Joe would work on his science, and Susan and I would be on the farm following my grandfather around, helping with feeding the calves, haymaking, gardening, weeding, planting potatoes, doing whatever we could to lend a hand. And then, in the afternoon, we’d do something with my dad—almost always a walk.

He would take us on walks around the Middleton tops, to Cromford, Ashover, Stanton Moor, Wingfield, Castleton, “Bonza”; to see the High Peak trail, Arkwright’s mills, the Crispin Inn, the Nine Ladies, Wingfield Manor, Chatsworth, the Plague Cottages, and the limestone districts with their lead mines.

For my dad, these afternoon walks weren’t satisfactory unless they were: 1) circular: that is, under no circumstances must one’s steps be retraced; 2) comprised of what I called the “three Bs”—bogs, bulls, and barbed wire; and 3) educational, in that we would see and learn about something new: stone circles, 14th Century ruins, stockinger’s cottages, blue John in the Crich Quarry, or even just wild orchids on the Middleton tops or my dad’s beloved Lords and Ladies in the hedgerows of Gregory’s farm. The best walks comprised all three elements.

On one of our walks along the canal between Ambergate and Whatstandwell (a decidedly noncircular walk, but made up for by its educational aspects in which the Industrial Revolution could be discussed at great length), my dad told me that the Derwent Valley is only one of two places in the world where there are four different forms of transportation in such close proximity: He counted them:

1. The Derwent River
2. The A6 road
3. The railway between Derby and Matlock,
4. The canal, built by Arkwright to ferry coal from Nottingham to Cromford to power his factory.

And of course, there was also the canal tow-path, built for donkeys towing barges, and now used by hikers and bicyclists.

The next time you drive down the A6 between Ambergate and Cromford, or walk along the canal, think about what my father said: that with one exception, there is nothing like this anywhere else in the world.



Ginnie and Joe on a walk near Newton Stewart, Scotland.

One of my memories from our summers in England is of a walk that we took when I was about fifteen with our Granny Smith. She should have known better than to join us, but she must have had a weak moment when her beloved eldest son asked her to join him on the limestone tops.

It was a lovely summer afternoon, and my father was leading us—Brenda, Susan, me, and my grandmother—on a walk somewhere over the tops of Bonsall. My grandmother was in her 70s, but she was game, and there was the promise of having tea out afterwards.

At first all was well; we started off at a well-marked stile, and managed to work our way through the fields surrounded by limestone walls, the ground pitted by the lead mines that had been dug in the last several centuries. But then, as sometimes happened, we lost our way. The path wasn't obvious, and soon, with my dad in the lead, we were clambering over the sharp limestone walls, boosting Granny over. She was not pleased.

Then, halfway through a field, we realized we shared it with a bull. We made for the edge of the field as fast as we could, stumbling over the rocky ground. I will never forget the image of my dad holding up one strand of barbed wire with his hands, holding down the lower strand with his boot while my Granny hiked up her dress and desperately hurled herself through.

I don't remember her ever again accompanying us on our afternoon walks, unless they were sedate walks to the Middleton tops, down the railway towards Black Rocks, or after-church strolls. But to my father, that walk was a success; we had overcome not only barbed wire, but a bull! And, even better: we had not retraced our steps.

Helping Out

My dad was not a cuddly sort of father; he showed his love in tangible ways. Whenever he visited, he was a blur of energy, painting, knocking together bookcases, weeding, digging over garden, tiling bathrooms. The summer of 1985, after his father had his first stroke, Joe dug and planted his entire garden for him. I remember my grandfather standing by the window in the lounge, tears streaming down his face as he watched his son do what he was no longer able to.

When I broke my leg while living in New York, and was in a cast for six weeks, my dad flew to New York and took me back to Beverly Shores, Indiana, so my mother could look after me for a week. Then he went to Michigan City and rented a wheelchair. Once or twice a day, he would take me out for "wheelies," pushing me up and down roads in the dunes and along the beautiful lakefront.

His attempts to help, though, sometimes fell short, though he tried his best. At the tasks of daily life, he could be incredibly obtuse. When Susan and I were around three and four, both of us and my mother came down with the flu. He put all three of us in their bed, and did his best to tend to us until my mother, desperate, was able to stagger to her feet, no doubt sooner than she should have. When my mother broke her leg one winter, he took on the job of laundering. He informed my mother that he was getting on with the laundry, but found there was only room in the washing machine for a few socks. "What?" she said. She'd been successfully putting through big loads of washing for years!

As he described his method of doing laundry, light dawned on my mother. Her husband had been putting the clothes in the little basket meant to hold the powdered laundry detergent, and all that fit were items the size of a couple of socks! Somehow, it didn't occur to him that no one would have used washers if this is how they worked!

"This is Marvellous!"

I have never known such a relentlessly optimistic person. For my father, mistakes were not grievous errors they are for most people; they were wonderful opportunities to learn or see something new. I can still see him clapping his hands together when something took an unexpected turn, saying delightedly, "This is marvelous," with a big smile on his face. And indeed, most of the time, it was.

One weekend, he came to visit me when I lived in New York City. He had hired a car to take me on a trip out of town. He thought a walk in a state park would be just the ticket for his New Yorker daughter.

He took out a map, and randomly picked a state park in New Jersey, across the Hudson River from the Upper West Side of Manhattan, where I lived. He started driving, using the sun and what he thought of as his own impeccable directional ability to guide him. We got on the Henry Hudson, driving what I knew to be north (it should be noted here that New Jersey is primarily *west* of New York City).

The major bridge leading to New Jersey, the George Washington, passed by on our left. Then the Tappansee Bridge, the last exit west towards New Jersey. But my dad seemed to have things well in hand, and I was enjoying the drive, so I didn't say anything, not that he would have listened, anyway. An hour later, we were still driving. My dad started talking about the deficiencies of the map: the state park wasn't where it should have been; clearly, a crazed mapmaker had been deliberately trying to fool us.

Finally my dad turned off the highway, and we drove on some back roads, hoping to come across a park—any park. Of course, he wouldn't ask for directions, even though I suggested that we stop at a gas station, and that I would be the one to ask.

The backroads became more and more narrow, and less and less well-traveled. Finally, the road became deeply pitted with potholes, and we dead-ended into a trailer park.

"Dad," I finally said. "I don't think this is right."

My dad looked a little chagrined. We hadn't reached a state park in New Jersey; we were in a trailer park in a completely different state. This would be rather like heading out for a lovely walk in Monsal Dale in the Peak District, and ending up in Birmingham.

But my dad pulled himself together quickly. "Wasn't that marvelous," he later recounted to my mother. "We saw a new part of the country!"

"A trailer park in Connecticut," I later clarified to my mother, out of my father's hearing. I didn't want to spoil his fun. And, it had indeed been marvelous!

A Dangerous Man with Clippers

He'd often joke that as the only man in his immediate family, he was hen- and pullet-pecked by his wife and daughters, and when grandchildren, three girls and a boy, came along, he'd say he was egg-pecked by his grandchildren. But the truth was, he ruled the roost, even when he was in your home, not his.

The first thing he'd do upon arrival, after reading the day's newspaper, was make a plan. It was always so interesting that we went along for the ride, for my dad not only was interested in science, he loved the arts, theatre; jazz, blues, classical, and early church music; English, American, and world history; architecture, botany, ornithology, archeology, and anything related to weather of any kind. And he was always



doing something-- sometimes when you wished he wouldn't. As my mother, my sister, and our cousins Alison and Julie knew to their detriment, he was a dangerous man with a caulk gun, a paintbrush, or gardening shears in his hands.

One day, about ten years ago, he got it into his head that Ballantrae House, my parents' house in Beverly Shores, Indiana, might sustain water damage from the rain. It was a wooden,

clapboard house, and it's certainly true that wood is porous. However, it's also true that throughout the history of humankind, wood structures have been known to withstand the onslaught of rain. But that wasn't sufficient evidence to stop Joe from going to work with a caulk gun.

He must have spent days putting the yellowish, viscous caulk on every single edge of every single shingle and every single knothole in the clapboards. "What is this?" I asked in horror on my next visit to Beverly Shores. My mother could only say, "Your father." There was nothing more to be said.

In 2005, when it came time to sell Ballantrae House, a real estate broker told my mother that she knew of a couple who were extremely interested in buying the house. But they had withdrawn their interest when they saw the stuff on the outside of the house. My mother didn't understand what the woman meant. "The, uh, the, uh, stuff on the outside of your house," the broker said. My mother still looked blank. "The stuff that, uh, looks like, uh, snot." Light dawned.

On my next trip, I spent most of three days pulling and scraping the caulk off the sides of the house, all done when I knew my father to be on the opposite end of the house. I had Katie and John posted as lookouts. When I was done, I had six enormous black plastic bags filled with the stuff. The house sold soon thereafter. We never told my father. Why ruin his fun?

Joe and the Printed Word

My dad never met a piece of print that he didn't like. He would read any words set before him: his beloved *New York Times* and the (more reputable of the) English newspapers; even cereal boxes and lists of ingredients, notes, jottings, personal letters, shopping lists. When the only paper available was *News of the World* or the *Sun*, that's what he'd read. I particularly remember him one time at his Auntie Dora's on the Crich Common. She was telling my Mum, sister, and me the local gossip out of the corner of her mouth (to Auntie Dora, you weren't really gossiping if you said it sideways!) We, of course, were avidly listening and my dad, who had absolutely no interest in gossip—he believed, rather primly, that people should be allowed to get on with their

lives without comment from others—would be reading Auntie Dora’s *Woman’s Own*. I always wondered what he got out of it!



Joe at our family birthday party for Meg when she turned four, two weeks after he and my mother arrived to live in Brookline. He’s wearing the special hat Meg’s preschool teacher had made for her and he must have already read the newspapers in my house, because he’s moved on to reading the ads with great interest!

In Praise of Limestone

After reading my mother’s piece, “Joe and Poetry,” I was rather surprised, and very pleased, to learn that my father and I had independently chosen the same line as poetry as one of our very favorites. It is Auden’s “In Praise of Limestone,” which begins:

If it form the one landscape that we, the inconstant ones,
Are consistently homesick for, this is chiefly
Because it dissolves in water.

My Beloved Father, Rest in Peace

In that last, terrible year, I came to know my dad as I had never before. For the first time in his life, he had to slow down, allowing me to spend long stretches of time with him. In his six hospitalizations, his three stays at a rehabilitation facility, and his recuperations at home with the help of a nurse, a physical therapist, and part-time home health aides for his last two months, we spent a lot of time together, sometimes just companionably reading the paper or doing the crossword, other times I'd be advocating for him with the doctors and nurses, getting him food, going with him on his walks up and down the hallways at the hospital, or when he came home, taking him on trips out to Pete the barber or just down the block. He was very appreciative of what we were doing for him, and incredibly brave.

Anyone else, I think, would have psychologically crumpled at the first heart attack and simultaneous fractured hip, but my dad persevered; his desire to live was just so strong. He never complained about having not only Parkinson's but congestive heart failure which resulted in a quintuple bypass last February, and five heart attacks, as well as a fractured hip. When more and more bad news kept coming, he'd just raise his eyebrows, and give a crooked smile, which was heart-breaking for my mother and me, because we knew how terrible it all was for him.

On his last night on Earth, my mother and I stayed with him in his hospital room, as we had the previous night. I'd asked the hospital staff to find his roommate another room, so we had the room to ourselves. I pushed the other bed next to my father's bed, so my mother could lie next to him and hold his hand, and I lay on a cot the nurse had brought in.

We had kept the blinds on the windows up, and around midnight, I looked out the window and saw the hospital's tall steam chimney, high in the night sky, reminding me so much of the chimney of Masson Mill in Cromford. An enormous full moon with its black and white patches floated directly over the chimney, and the steam from the chimney created ripples in the face of the moon. I thought then of my father's wonderful, generous spirit rising through the night sky, past all the workings of humankind, towards the moon, and of his life's work, his passion to understand the origins of our planet Earth and protect the natural world, and his equal passion to use scientific achievement to better the lives of humankind. He died at 4:35, in the early morning of Good Friday, holding my mother's hand, the dearest thing to him in life.

And now that my beloved father, our farmer's boy, is gone, all I can do is remember the optimistic way in which my father lived his life, and what my Granny Smith wrote forty-five years ago:

“The glass is rising and we hope for a better week.”

*A LETTER FROM JOE'S MOTHER TO JOE AND BRENDA IN WASHINGTON,
D.C.*

Written, as were all overseas letters, on light blue airmail letters

Summer 1952

*Baru Close
Friday*

Dear Joe and Brenda,

I have two of your letters to answer this week as yours arrived this morning. Thanks for the snaps. I don't think Joe looks unduly serious. It is his natural expression. I like the one in the white shorts best. The farm institute looks a fine place.

We have had almost continuous drizzle & showers this week, and everything is covered with sticky mud, which tramps into the house everywhere.

We have had a number of cows and one heifer calve, mostly bull calves but not all, & so we have now more milk. But we are feeding with cabbage & our straw as we have had no grass grow this last summer. The aftermath was so short too that the cows cleared each field in a very short time. Now it is too wet to get the wheat in but the glass is rising & we hope for a better week.

We went to look over two farms on Thursday & I never had seen two such ruins. Daylight shone through one house in several places where it shouldn't, & both were fastened together by bands everywhere. Neither has electricity & one fetched drinking water from a spring in the field. I could hardly believe it, & my old ruin looks like a palace today, in contrast.

I am sorry to have more bad news for you, but Tom is in the Infirmary again with a broken jaw this time. He did it at work when a piece of wood caught him. This certainly seems to be his unlucky year. There has been a meeting today at Orich to decide what is to happen to the business.

[Norman and George Smith, Henry Smith's brothers who ran the Smith family carpentry business in Orich, had just died—Norman of a heart attack, George a suicide at the loss of his brother. Joe's brother Tom had been promised the business, but because the will hadn't been signed, it passed instead to an in-law who was unable to sustain the business.] It [the meeting on the future of the business] should have started at 11 a. m., & I understand they were still at it at 5 p. m. Perhaps I shall be able to tell you the result next time I write.

Now I must leave space for the chutney recipe—

Ingredients

*1 lb. ripe Tomatoes
1/4 lb. onions
1/2 lb. sour apples
1/4 lb. stoned raisins or sultanas
1/4 lb. brown sugar
1 1/2 teaspoons each of ground ginger, cayenne & salt
1 gill (1 1/2 pt.) malt vinegar*

*Pour boiling water over tomatoes then skin and cup up fine.
Peel & core apples & cut small, peel & chop onions. Put all ingredients into a deep enamel pan & boil down to a purée, stirring occasionally, until soft & a bright colour.*

If you don't like it to bite your tongue too much I should put a little less cayenne.

Now I must get to bed with hopes of a great success with the chutney.

Thank you so much for sending the parcel which we look forward to receiving in due course. I only hope you are not stretching the finances too much to do it.

*Love from us all
Mother*

Memories of Dad

by Susan Smith Werther

When Ginnie and I were little, Dad walked us to school across the Midway, a park originally built as the fairgrounds for the Columbian Exposition held in Chicago in 1893. On the way I held Dad's hand, and if it was cold I would slip both of our hands, still clasped, into his pocket. His coat pocket was roomy and comfortable, but his pants pocket was a rather tight fit. It didn't matter; either way I felt safe and warm, walking to school hand-in-hand with my father.

In the spring of my Kindergarten year, Mrs. Johnson asked our class to keep an eye out for robins and let her know how many we had seen each morning. After a few days, our little classroom tree was populated by a little family of paper robins, one for each reported sighting. Later in the week, we came across a whole flock on our way to school. Dad helped us count them, and I rushed into the classroom to report that we had seen eighteen robins! True to her word, Mrs. Johnson cut out the requisite number of birds, and then carefully announced the tree was full and the project was over.

As we got older, kids at school would ask each other, "What does your father do?" One year I would answer, "My dad's a crystallographer," the next year, "a mineralogist." Hoping for a little clarification, I asked him one time, and he said "At Cambridge I studied chemistry and physics." We eventually settled on "geophysicist" (although he loved to say that he'd never taken a geology class in his life). For us, words like zeolite, kimberlite, and feldspar were household names but it was hard to explain to our friends exactly what it was that Dad did ... until the Apollo 11 Mission.



In the late 1960s, Dad was involved in the analysis of rocks brought back from the moon. It was a very exciting time, and we and our friends all wanted to hold a piece of the moon. In order to prevent contamination, we were only allowed to touch a thin section of moon rock, mounted between two pieces of glass, designed to be viewed under the microscope. Because of the necessity for high security, Dad kept all samples locked in a safe in his office. One evening, at dinner, Dad reached into his shirt pocket and pulled out what appeared to be a small rectangle of glass. "What's this doing here?" Dad asked. It turned out to be a thin section of the moon. Ginnie and I got to touch it but were told not to tell the story to anyone at school.

During that time, there was an exhibit of moon rocks at the Field Museum of Natural History in downtown Chicago. Jane Burn, appointed head of consumer affairs by Mayor Daley, asked Dad if she could make a wish while touching a piece of the moon. Dad accommodated her, presumably without contaminating the specimen, speculating later that her wish (to become the first female mayor of Chicago?) had come true!

Thanks to the moon, we finally had something to say about Dad's profession that people could understand. Of course we also had to put up with jokes about green cheese.

With Dad, we were always going places--to state parks, museums, concerts, plays, historic villages, camping trips. During the spring of 1965, Dad took a sabbatical at Cal Tech in Los Angeles. In March, we packed the car and traveled west, camping out along the way. We stopped at Mt. Rushmore, drove through Yellowstone, crossed the Rockies, stood at the lip of the Grand Canyon, visited Joshua Tree National Monument, slept in Death Valley, and drove through a hollowed out Sequoia tree along the Pacific coast.

During the long days on the road, Dad would quiz us on the local geology. "What do you think formed that hill? What caused the red stain on those rocks?" Peering out at the landscape, we would call out, "glacial till" or "iron," hoping we were right, waiting to be told the answer. One time Dad asked us a question, and we trotted out our small repertoire of possible answer, and then waited for his verdict.

"Okay, we give up. What's the answer?"

"Hmm? Oh, I don't know," said Dad, "I'm was just thinking. I'm always asking myself questions, everywhere I go. I want to learn as much as I can about everything I see."

Nearly every summer we went to England. Birchwood Farm was our epicenter, but we would make the rounds of all the relatives, and take side trips to parish churches, well dressings, market places, stone circles, Roman roads, and historic sites from the Industrial Revolution: stocking mills, abandoned lead mines, cottage industries, limestone quarries, water mills, and canals. We'd travel down to Cambridge and go punting on the River Cam, visit Mike Bown and family, and go to King's College Chapel. Once we made a trip over to the continent, spending a few weeks sightseeing in Paris, and visiting Mum's pen pal in the Loire Valley, with quick trips to Germany, and Switzerland. Along the way, Dad visited colleagues at various universities.

In Scotland we stayed at Cleughhead, a little whitewashed cottage in Galloway, overlooking the ocean. In the mornings, Ginnie, Dad and I would walk down the steep, honeysuckle decked lane to buy milk and eggs from the lady at Castle Farm. Along the way, Dad would sing,

"Fanks for the memory of foodle fangle fing,
and dogs that like to sing,
and rumpty tumpty tiddle umpty,
fooddle fangle fing, and thank you for it's true ..."

claiming all the while that he couldn't hold a tune.

We played in tidal pools on deserted beaches, climbed rocks, explored caves, castles, and lochs. We visited our cousins Rosie and "Woolley" at Lochside Cottage, and all the old haunts that Mum had frequented during her holidays in Scotland. One year we helped a farmer harvest his wheat, setting up stooks the old-fashioned way. Another time we watched the sheep shearing, and rode on a wagon full of freshly shorn wool (which our cousin Peter stuffed down our necks!)

We followed footpaths, and meandering sheep paths and sometimes made our own paths to reach our destination. We took “Smith walks,” which generally involved scrambling over walls, through brambles, under barbed wire fences, over bogs, and once diagonally across a farmer’s wheat field to keep a footpath open. The best walks were planned so that we would arrive at a relative’s house just in time for tea.

Tickling sticks were Dad’s own invention. He would pluck a long piece of grass, preferably one with lots of dangly seeds on the end, find the approximate mid-point and place it into his mouth, pursing his lips until the grass was bent double. He would then continue twitching his mouth as he brushed the seedy end across his victim’s face and neck. This activity proved to be particularly helpful to perk up tired children when taking long walks in the country.

Dad loved to explore, on foot or by car. “I always drive by the sun. I enjoy taking these little back roads and getting off the main drag. I always know approximately where we are. The coast is that way, and the (park, manor house, waterfall, castle) should be just around this next bend ...” And his sense of direction was not confined to the countryside, “I can step up out of a subway in just about any city in the world, and get my bearings.” And, oddly enough, wherever he went, people would stop him and ask for directions. (However, in the syllabus for his course “Geology and Human Welfare,” Dad wrote the following: “Do not wander away from the chosen path: jvs has spent up to an hour getting out of difficult terrain when exploring off-trail sites.”)

Dad was a man with a mission, and always on the move. Dr. Glover, a geologist from Madison, once referred to him as a “a breezy young man.” “Wasn’t that brazen?” Dad quipped when I told him the story years later. On walks, he forged ahead, an energetic figure on the road up ahead, suit jacket flapping, tie blown over his shoulder.

Even when sitting, he had crossword puzzle going, or his nose in a book, sometimes when (or perhaps especially when) the rest of us were chattering away. “Dad, are you listening?” Up came his head, “Yes, Jimi Hendrix--I haven’t missed a thing. Now, I need an old Testament prophet beginning with “H,” five letters.”

In 1976, Mum and Dad bought a house in Beverly Shores, Indiana, situated on top of a dune overlooking Lake Michigan. Named after a beach in Scotland, and one of Mum’s childhood homes, Ballantrae House became a weekend retreat from the city. Over the years, Mum and Dad transformed this sandy plot of land into a haven, with flowering shrubs and trees, beds of roses and vegetables. Dad planted pines, and transplanted dune grass to stabilize the sandy soil, and built a high fence around the property to keep out the deer. He also set live traps to capture raccoons and the occasional possum. “He’s going on his holidays!” Dad would call out, as he hoisted the crate into the car to drive the hapless creature off to where he would, no doubt, do damage to someone else’s garden!

In the early morning, Dad was out watering, clipping and weeding, before the heat drove him inside for a cup of tea and a biscuit. In those early years, there was often a load of dirt at the top of the driveway. Dad would shovel the rich black loam into a wheelbarrow, and cart it about to improve the quality of the sandy soil. Soon piles of bricks arrived, and Dad was busy making paths that circled the house, and crisscrossed the dune. With the help of Mike, a local handyman, decks and walkways were built that encircled the garden and went up around the house to the back door. The house was now wheelchair accessible, and all the windows could be washed without the use of a ladder.

Christmases and Thanksgivings were now spent at Beverly Shores, and we often had friends come out for the day or stop in for tea. After dinner, Dad would sometimes put on a record of Scottish bagpipe music and begin marching--with knees high--up and down the room, waving an imaginary baton. He would then invite small unsuspecting children to join him, and when they least expected it, he would turn suddenly, growling and gnashing his teeth, and march menacingly towards them as they scattered, shrieking in terror. (Marching can be done with one's own children, or those of visiting friends and relations.)

One summer, Sue and David Zesmer (parents of my good friend, Sarah) came by, and we all sat out on the deck overlooking the lake. David is a Shakespeare scholar, and we often had lively discussions about theater and many other subjects. This particular day Mum and Dad were getting ready for their play reading group. Mum was to be Pozzo and Dad, Didi in *Waiting for Godot*. Dad disappeared for a while, and then popped his head through the patio door. "Brenda," he asked "do we have a whip?" "What do you mean, 'do we have a whip?' Of course we don't have a whip." We all laughed heartily as Dad went off to find a substitute for the needed prop. After a bit he reappeared wearing a pair of baggy pants. "Come join us for a cup of tea, Joe" said Mum, when all of a sudden he dropped his drawers, revealing a pair of striped boxer shorts. It's a good thing the Zesmers were familiar with the play, or they might have called in a high priced loony doctor.

The dunes turned out to be a perfect laboratory for Dad's classes at the University. When teaching "Geology and Human Welfare," he would bring his class out to the Dunes for a field trip. They would study the geologic history of the area, and discuss the early settlement by Native Americans, the French and English. At the Indiana Dunes State Park, Dad would send the students on a geological/botanical treasure hunt. They would then walk along the coast and study plant succession and beach erosion. Arriving at Ballantrae House for tea, Dad would continue to teach as they all ate.

Always the farmer's son, Dad took his students to visit the Chelburg Farm, built in the 1800s and situated just a few miles down the highway. It was a place where we could see horses and cows, and a flock of hens pecking about in the dirt. There was an old hay barn, and a small farmhouse, and the Bailey Homestead a short walk away. Several times a year there would be a festival with demonstrations of the old farming techniques. With the arrival of grandchildren, and grandnieces and a grandnephew, there was even more reason to make the trip. "Who wants to go to the Chelburg Farm?" he would call out. We all did, but we knew that it was Dad who wanted to go the most.

Dad was a great encourager and promoter. He had great ideas for himself, others and the world. "We should write a children's book, Sue, with different atoms all holding hands, to teach elementary chemistry. You could illustrate it." However, with Jessica still not sleeping through the night, the project never got off the ground.

"You should get that memoir published," he said to artist friend, Prof. Robert Grilley who had written an account of his days in the air force during World War II. This time, the project flew, and "Return From Berlin: The Eye of the Navigator," was published.

Although we often teased him, and Mum would often say, "Oh, stop pontificating, Father," I still remember his advice: "Organization is the key to success."

"Take each day as it comes, leave the past behind, look to the future with confidence."

"Sometimes you have to just shrug your shoulders and move on."

“I’m a farmer’s son. I get up each morning and do what needs to be done. Pace yourself. My father always worked steadily, and took a nap under a wall after his lunch.”

“I’m not brilliant, I just work hard. I was lucky--I came through at a time when there were lots of opportunities. Doors were open, and I just walked through.”

“Take chemistry. No matter what profession you choose, a good knowledge of chemistry will be of help to you in life. Memorize the periodic table. Take calculus.”

“Have you read the instructions?”

Homework: “You’re a smart girl; you can figure it out.”

Anything emotional: “Why don’t you go talk to your mother.”

Diet: “Our ancestors ate the same foods for hundreds of years: potatoes, meat, vegetables, bread, fruit. I suggest you eat a variety of foods in moderation. You should also supplement your diet with small amounts of (fill in: zinc, iron, potassium, vitamin C, vitamin E, selenium). For vitamin D, I take my glasses off and let my eyes absorb some sunlight for 10 minutes each day. I’m just a simple man. I don’t go in for fads.”

When Mum and Dad arrived in Madison for a visit, his first request (after a cup of tea, and a sandwich) was to see the entertainment section of the paper so we could start planning the weekend. Then he would read off a long list of possible activities: “We could start off at the farmer’s market--there’s a jazz band playing at ten--have coffee and a scone, and then drive out to Olbrich Gardens to see the spring flowers. Then we could stop at a restaurant for a bite to eat, and on the way back stop by the Elvehjem Museum--there’s a special exhibit of 19th Century etchings. And in the evening there’s Scandinavian dancing at the First Congregational Church. Hmm? No, we don’t have to do it all; I’m just letting you know what’s on. Here, you take a look at the paper and let me know what you’d like to do. I’m on holiday, there’s no a hurry. I’ll be out in the garden doing a bit of weeding. Do we have any soup for lunch? with beans?”

Wherever he went, Dad had a penchant for trimming, pruning and hacking back unwanted plant growth. Nothing was sacred: no tree, bush, shrub, or briar was safe from his clippers. “Dad, wait, don’t take so much off!”

“Don’t you think that’s a bit drastic, Dad?”

“No, no, don’t you worry--they’ll come back nicely in the spring. It does them good to be cut back a bit; it stimulates new growth. I know you lead busy lives and don’t have time to do these little jobs. I’ll just do some chop-chop, and you can clear away the debris when I’m through.” Even the vegetation on other people’s “back forty” wasn’t off limits. “Joe, this is someone else’s property!” “It’s all right, Brenda, I’m just cutting back these vines. See how they’re choking the trees? Most people don’t know how much damage they can do; they latch onto the tree and eventually kill it. I’m actually doing them a favor.”

In addition to having a green thumb, Dad was always fixing things: “Have you got a wrench, Sue? And I’ll need some paper towel, and a hammer, please. I’ll just take a look at the pipe under your sink. You’ve got a bit of a leak.”

“In a minute, Dad. We’re not quite done with lunch ...”

“Take your time, I’ll just get started.”

“Dad, wait, that’s a good towel you’re using--here’s some paper towel.”

“Fine, now that job’s done. I think I’ll go outside and see if those bushes need a bit of clipping.”

“Where did Dad go? Why is this door open? Where are the cats? And why are there muddy footprints all over the kitchen floor? Where’s Dad? What’s he doing now?!”



John, Brenda, Susan, and Jessica at Ballantrae House, August 2005

One summer, in Madison, Dad surprised us by making lunch--home made soup with the vegetables cut big and chunky (he called this process “chop-chop“) with lots of beans, the way he likes it. The table was set with soup bowls, silverware, hunks of bread and slabs of cheese. We all squeezed into the little dining nook, and as I took a seat, I noticed that at each place setting Dad had laid a paper napkin, folded into a triangle, and on each napkin was written in blue ink, the word “love.”

Dad was very concerned about the earth, and in the year 2000, he began raising money to set up a series of international conferences, one on each continent, where scientist could meet to share ideas on how to protect the earth, such as predicting, and possibly deflecting an approaching asteroid, and using scientific collaboration to prevent wars. He talked about “The Joseph Project,” (the name taken from the Biblical story of Joseph in Egypt) which involved the storage of food, in the event of a worldwide catastrophe. Unfortunately, with the advent of 9/11, federal funding was directed elsewhere, and the conferences were never held.

In the syllabus for Geology and Human Welfare, Dad included what he termed the Hippocratic Oath for earth scientists:

‘I vow to practice my profession with conscience and dignity; I will strive to apply my skills only with the utmost respect for the well-being of humanity, the Earth, and all its species; I will not permit considerations of nationality, politics, prejudice or material advancement to intervene between my work and this duty to present and future generations; I make this oath solemnly, freely and upon my honor.’--The Institute of Social Inventions

And he would begin each class with a poem or passage from literature, including this one from *Paradise Lost*:

To ask or search I blame thee not, for Heav’n
Is the Book of God before thee set
Wherein to read his Wond’rous Works and learn
His Seasons, Hours or Days, or Months, or years.

John Milton, *Paradise Lost*, VIII 66 ff.

* * * *

Thank you, Dad, for all the places you have taken us, and for all that you have taught us. Thank you for sharing your love of learning, your love of nature, music and art. Thank you for your vision, your optimism, and your concern for the earth. Fanks for the memories. Thanks for your love.

“He will swallow up death for all time, and the Lord God will wipe away every tear from their eyes.” Isaiah 25:7-8

“Behold, I make all things new.” Revelation 21:5



Joe, Brenda, and Jessica on a lane in Derbyshire.



JVS on his 78th birthday with Brenda and granddaughters Katie and Jessica.



JVS with John and Katie getting water from a spring, Beverly Shores, IN.



Joe and John at Halibut State Park, Cape Ann, Massachusetts.



Joe with Meg at John's class breakfast with children, parents and grandparents.

Thoughts on Uncle Joe

Alison Smith Watson

Uncle Joe was special to me; he was more than an uncle. From as far back as I can remember he was 'the moon rock' guy. We often were allowed to drop in on Uncle Joe's lab at Christmas. It was usually to get stamps from around the world that Uncle Joe had saved for me as part of my Christmas present. I remember when he told me about a stamp from the new country Malawi and how he had saved me a stamp. I felt the luckiest girl in the world. On one visit to the lab Uncle Joe brought out some gray coloured rocks and then let us hold them. Again we were privileged; we had held actual rocks from the moon.

Most Christmases when I was young were spent in Chicago. This meant Rockefeller Chapel Christmas service, walks along the lakeshore Christmas morning and sometimes a trip to a zoo. Each Christmas our height was measured against the door jamb in the kitchen.

In my teenage years, Auntie Brenda and Uncle Joe moved to Ballantrae House in Beverly Shores, Indiana. This brought its own experiences. The house was one hour closer to our home which allowed us to visit a little more frequently. Uncle Joe still led walks of the area. One of the special things here was that I usually slept in the kitchen/den. I was able to spend precious time alone with Uncle Joe as he arose early and I would sit up and talk to him- he tolerated my teenage ramblings well.

Uncle Joe and Aunt Brenda made trips to the farm that James and I own in Annan, Ontario. They made it up the fall after my oldest daughter Julie was born and seemed to delight in taking her for a push in the stroller. One spring they came and we picked strawberries. While Auntie Brenda and I made jam, Uncle Joe weeded my vegetable garden! They made a trip each fall to Stratford, Ontario to watch a play at the Shakespearean festival and came to visit us. This visit often coincided with my children's fall fair and they were quite proud that Uncle Joe and Auntie Brenda were able to attend. After the fair was over the girls would proudly load the trunk of their uncle's car with all of their entries and be off, being brought home in the car while everyone else rode the bus.

On one trip Uncle Joe spotted a Pudding Stone on my mother-in-law's doorstep. A Pudding Stone is a rock that comes from St. Joe Island in Northern Ontario. Of course, the Pudding Stone made the trip back to Ballantrae House (with a supply of bricks left behind that had to be taken out of the car to make room for the Pudding Stone).

James (my husband), the three girls and I made several trips down to Ballantrae House. One memorable one was when Uncle Joe convinced James to climb up a ladder with a chainsaw to cut off an offending branch. Needless to say when the branch was cut, it swung down hitting the ladder James was standing on leaving him hanging from another branch. This is an event he will never forget and neither will I as I watched the event from a large picture window in the house.

When we heard that Ballantrae House was being sold, the girls insisted that a trip be made. My mom and I took them down for a last visit. This entailed a trip to the famous dinner spot Long John Silvers, and with Uncle Joe and Auntie Brenda spoiling the girls.

Uncle Joe (and Auntie Brenda) hold a special place in Julie, Fiona and Cynthia's hearts.

On Easter Sunday, two days after Uncle Joe's passing we arrived home from church to find a cold newborn calf had been born in the snow. We moved the calf into to the barn, but realized that he needed to be warmed up. The calf was brought into the kitchen for the hair dryer and towel treatment. As with all calves that make their way into the kitchen, he had to be named. Of course, there was only one choice in our minds and Joe it was.

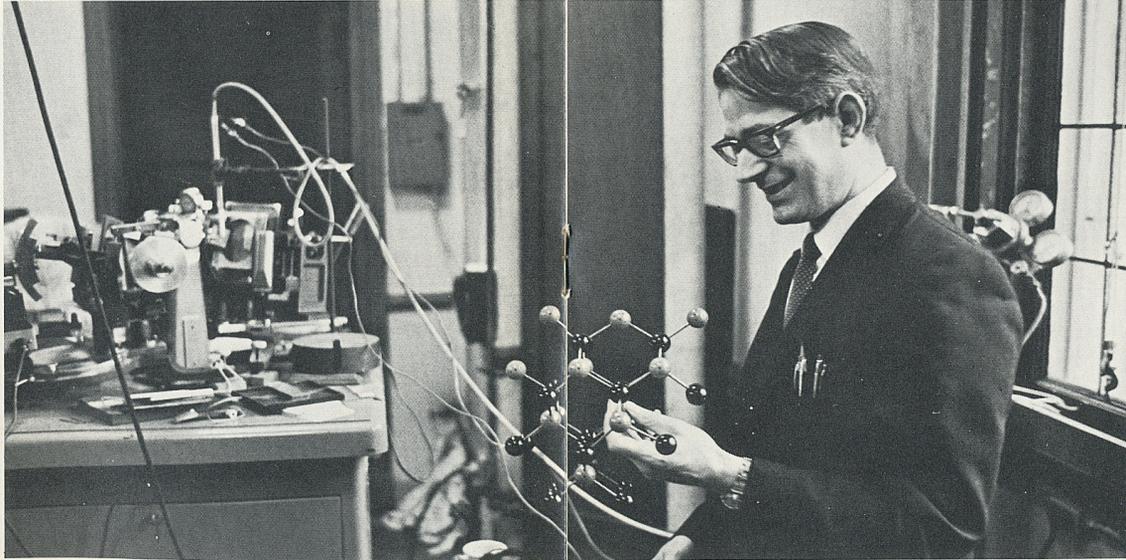
We will never forget you Uncle Joe; you are forever in our hearts.



Tom, Glennis, Alison's baby daughter Julie, Alison, Joe.

wave-induced subsurface movements, return flow under shoaling waves, the mechanics of internal waves in deep water, and sediment transport and deposition associated with some of these phenomena. Much of this is done at Woods Hole, Massachusetts, but an important item of lab-

Sciences and the Division of the Biological Sciences. Marvin J. Weller, Professor, also active in this Committee, is in a sense a historian interested in reconstructing land-sea relations, the fossil and evolutionary record, and deducing past environments from the sedimentary rocks.



Joseph V. Smith

CHICAGO TODAY

FALL 1964

Joe with crystal structure, Rosenwald, University of Chicago.



JVS on top of a dune at Indiana Dunes National Lakeshore, where he'd later bring University of Chicago students on field trips.

Memories of Colleagues and Friends

Michael Foote, Chairman of the Geophysical Department, University of Chicago

Joe was not only an important figure in mineralogy and crystallography, but also a key player in the growth and development of the Department and in the strengthening of our ties with Argonne National Laboratory.

We will all miss Joe and will fondly remember him for his contributions to science, the Department, and the University.

Henry Emeleus, geologist, University of Durham

Joe was a great person in all respects and a real friend to me for many years—almost fifty in fact! I owe him much, from suggesting we write a paper on Irish feldspars (what else?) to teaching me to use the microprobe and arranging my visit to Chicago in order to do this, and in many other ways.

Many years ago, we did a tour of Scotland looking at “classic” geological sites—it was my first long field trip with Joe, and I still marvel at the interest at he had in all aspects of the rocks we looked at—from their minerals (kyanite comes especially to mind) and their significance to how the rocks influenced the farming. He will be greatly missed.

John Valley, professor of geology and geophysics at UW Madison

It was such a pleasure for us to see Joe and Brenda when they came to Madison. He seemed never at a loss for a new, exciting, and creative idea. His ability to synthesize science with art and life was always enjoyable.

Joe’s ability to think and act on many planes was inspiring. His achievements in mineralogy are legendary and he was among the first to develop and use new techniques including the electron and ion probes, and the synchrotron. His vision was to employ science for the good of mankind and that was his greatest contribution of all.

Michael Bown, friend from university, and former professor at Clare College, Cambridge University

Richard Born, curator at the Smart Museum, University of Chicago

It is hard to think of such a vibrant, curious, and kind man no longer being among us.

We closed last Sunday an exhibition in the Old Master Gallery devoted to portraits in honor of fellow artists, and many of the most beautiful and important of the Etching Revival prints in the show were the direct results of Joe and your generosity. One of our curatorial interns recently opened in our Print and Drawing Gallery a glorious show featuring Japanese color woodblock prints from the first decades of the Twentieth Century. With one exception, I believe all the pieces are gifts from you and Joe.

Both shows are lasting testaments for Joe's passion for fine print-making—not bad for a quote farmer's boy, unquote, as he liked to say.

Dr. Regis da Silva, Joe's cardiologist, Beth Israel Medical Center, Boston

He was a noble and lovely man who bore his illness admirably. I enjoyed very much the privilege of taking care of him.

Jack Zusman, retired geologist, University of Manchester

It's such a long time since we first met as research students at the Cavendish, and I'm glad we were in touch for most of that time. It was a pleasure to hear of Joe's achievements in science, also a privilege to count him as a good friend.

Max Carman, geophysicist at Pomona

I was a young professor at the University of Houston in Texas, struggling to get started in research on alkalide feldspars, when Joe helped me greatly in learning to use the electron microprobe. I highly prized Joe's friendship.

Joe was a great scientist and fine human being, one of Nature's noblemen, as the time-worn saying goes. His warmth and humor I'm sure aided and inspired his students and friends, as it did me.

Pat Swanson, fundraiser at the University of Chicago

"J.V." was an outstanding scientist, a broadly educated humanist, and a patron of the arts, as well as a person of great civility. He was always, for me, indeed for many years, a personification of the phrase "a scholar and a gentleman."

Bill and Mary Carstedt, friends from the Beverly Shores, Indiana, playreading group

We treasure memories of Joe's sensitive portrayal of Alan Turing in "Breaking the Code"; our enlightening and often hilarious Shakespeare evenings, the special times with you in your lovely home.

He fought the good fight. He was a remarkable man.

Mabel Corlett, former student and geologist at Queens University, Canada

In German, the thesis supervisor is at least colloquially called the "Doktervarter," and Joe was certainly that to me. This was true not only academically, but perhaps more importantly, in learning something about what is now called "life—work balance." Babysitting the girls, I could see him work so concentratedly during the day, then transform into father, husband, music lover in the evening, and on holidays (camping in Wisconsin, visiting you in Cambridge). I am grateful to all of you.

Matthew Adkins, family friend at the University of Chicago

Almost from the time we moved to the States, going to see Brenda and Joe was more like visiting relations than family friends. A haven of Northern England sanity in a sea of 70s and 80s American chaos. Over here (in Japan), watching Japanese people enjoying the peak of the cherry blossom season, I've been thinking of Joe's very English, no-nonsense love of nature.

I will miss him very much.

Maggie Newman, friend of both Joe and Brenda

I have the most delightful memories of Joe, exuberantly hosting your Christmas parties and warmly recall his giving me a tour of the etchings so beautifully on display.

Keith Moffat, CARS, University of Chicago

Joe was a visionary and an inspiration. My first memory is of Joe and me on hands and knees on the floor of our living room in Ithaca planning CARS before we'd even moved to Chicago.

We'll miss him!



Living Safely

Joseph V. Smith

*Louis Block Professor of Geophysics
The University of Chicago*

This book is a guide to the many dangers that face us throughout life. It offers practical advice on how to try planning for safety over the next generations and into the future. Joseph Smith uses his own experiences as a farmer's boy in England and as a research professor at The University of Chicago to illustrate the wide range of dangers that threaten us and our species. His early life in Derbyshire, a cradle of the Industrial Revolution, reveals the intimate ecological features of a traditional community of farmers, miners and factory workers. His advanced training in physics, chemistry, geology and mathematics at Cambridge University and the Carnegie Institution of Washington set him up for a research career that ranged from the origin of the Moon to the application of mineralogy and crystallography to industrial chemistry. In recent years, Professor Smith has argued that the human race is wasting its resources on dangerous war machines, instead of protecting itself from inevitable dangers that include impacts from comets and asteroids, and change of sea level. In this book he compares all the dangers that threaten us, and shows how individuals and governments could reduce suffering by appropriate decisions. Joseph Smith demonstrates that the scientific and engineering needs are clear except for timing of major destructive events, whereas the ethical, sociological and economic ones are not. He concludes with a plea that we try to stop acting like primitive tribes hunting heads and develop a feeling that we belong to one race irrespective of skin color, religious sect and historical groupings.—J.V. Smith

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BIBLIOGRAPHY

Introduction

Who Am I and Why I Wrote This Book

I was born on a small hill farm at Crich, Derbyshire, England on July 30, 1928, and moved to Barn Close Farm, Fritchley in 1929. I learnt instinctively about ecology from my father who used traditional methods to keep his land "in good heart." With encouragement from my mother and an uncle, both of whom had been school teachers, I won a scholarship to the Herbert Strutt grammar (USA = high) school in Belper. Although World War II brought shortages of food and clothes, and fears of military invasion, I was spared the direct agonies that afflicted most of Europe and much of Asia. Nevertheless I learnt directly about the tragedy and excitement of war, and have studied the history of conflicts ever since. It is difficult for this complex history to penetrate the USA government whose current members appear to think that a big military can determine the future of events around the world.

In the Spring of 1945, I won scholarships to Gonville and Caius College of Cambridge University. The ending of the European war on May 9, 1945, and the Pacific war on August 10, 1945, just kept me out of the army. I was lucky because I was stupid enough to hanker after the thrill of driving a tank and blasting those Nazis to bits. The atomic bomb seemed like a miracle weapon that came just in time to defeat the Japanese aggressors with their destructive kamikaze behavior, and I did not appreciate its danger for civilization until I learnt the scientific and engineering principles of nuclear reactors and explosives, and the excitement of building and installing new weapons and delivery systems. Since then, I have consulted with scientists at the mostly-nuclear Lawrence Livermore laboratory, and have become convinced that nuclear weapons must be controlled and ultimately abandoned by all countries, including the USA. Perhaps the nuclear weapons labs should ultimately be reassigned to investigating with NASA how best to identify

dangerous comets and asteroids, and whether sophisticated ideas like steering them to impact the back of the Moon have any hope of becoming technically viable.

At Cambridge, I studied physics, chemistry, mathematics, crystallography and mineralogy, and graduated in June 1948. Many students had served throughout World War II, and their drive and maturity fortunately rubbed off on the young innocents like me. We listened skeptically to Bertrand Russell and supported the United Nations Association. Communism became a nagging worry as the Cold War developed. Colonialism was starting to fade, but many of the new states, particularly in Africa, were slipping into barbarism. Europe and USSR were tense neighbors as the empire-building Russian-dominated USSR tried to take over various unstable countries. Ultimately the break-up of USSR has opened up the situation, but very complex interactions occur in 2007 among the Russian, Muslim and mixed countries that resulted from the break-up of the USSR.

I was fascinated by radar technology when I interviewed in 1948 for a job at the Malvern laboratory. Only in 1986 did I read the technical details of its role in the murderous bombing offensives of World War II. These were presaged by the Zeppelin attacks on London in World War I, and by the Nazi carpet bombing of Guernica, Spain, in 1937. It is quite obvious now that the happy innocence of a research scientist is easily perverted by the stresses of war, even of a "just war." Most inventions can be used for life or death, and my advanced training in Cambridge gave me the choice of two roads. Was it luck that I stayed out of the military world, and became a research student working on "pure" science at the Cavendish Laboratory? Or was it my instinct as a farmer's boy to work on "real things" of direct value to human welfare?

I decided that crystals and minerals were more fascinating than the abstruse concepts of nuclear and particle physics, and became a crystallographer. I received a Ph.D. in 1951 for determination of the crystal structure of the calcium-carbonate-silicate mineral tilleyite using X-ray diffraction. The calculations were very tedious because computers were only just becoming useful. Nevertheless, it was a great time. We graduate students thought that "pure science" would lead the world to a better life, and did not foresee the harm that might ensue from so many new discoveries. However, the Cold War was beginning to upset our complacency. We discussed the technical possibilities of further developments of nuclear power and of fission and fusion bombs; of course, we had no specific knowledge of the secret work of the weapons scientists and we knew nothing about the political shenanigans in the capitals of the major powers. It was claimed that nuclear power would produce so much electricity at such a low cost that it would be hardly necessary to charge for it! Now we know about the difficulties of storing nuclear waste safely, and the future of nuclear power is very controversial when alternative sources of electricity are considered.

Most of my scientific research has related to mineralogy. At the intellectual level of pure science, I have had a wonderful time studying minerals selected from rocks from the Earth and the Moon (including its first new lunar mineral, *pyroxferroite*), and on meteorites, including one from Mars. On a practical level, I have worked on mineral-related synthetic catalysts that have truly revolutionized the chemical and petroleum industries, but even here I have been able to relate modern structural chemistry to pure mathematics going back to Plato, Archimedes and Kepler. Furthermore, I have been able to teach students from around the World about the physics, chemistry, biology and mathematics of minerals, and have been

able to profit from their descriptions of their diverse backgrounds.

On the negative side, I have been forced to consider how certain minerals can be bad for human health. In Derbyshire, I saw the medical effects of lead poisoning and of drinking water low in iodine and fluorine, together with bronchitis induced by dirty industrial air. I am still affected by the consequences of air pollution and of drinking well water low in iodine and fluorine. In the Chicago region, I still see the effects of air and water pollution from intense industrial and agricultural activities. Fortunately, these medical problems are being reduced in much of the developed World by detailed scientific studies followed by legal and political actions. The overall success in the USA of the Environmental Protection Agency sets an example for other countries, though this agency faces day-to-day political & financial pressures. However, traveling around the World, I have seen the growing evidence of dangers to human health from poor air, water and food, typically aggravated in slums resulting from the growth and movement of increasing numbers of young people desperately seeking a better life, or any life at all.

On the positive side, I have helped industrial scientists triple the yield of gasoline (petrol) from oil. Together with advances in drilling and exploration that have yielded three times as much oil from fields, this almost ten-fold advance in the past half-century has made it possible for many of us to travel rapidly around the World. This freedom to travel anywhere if one has enough money may be fading as the availability of oil is topping out.

On the negative side I have been truly appalled at the development of dangerous useless nuclear/rocket weapons, and the sheer waste of energy and money in so many vicious military and civil conflicts. The people of the World have yet to take sensible steps to guard against impacts from asteroids and comets, let alone the problems caused by earthquakes, volcanoes, landslides, coastal erosion, and other major geological hazards.

At the National Academy of Sciences Colloquium on *Geology, Mineralogy and Human Welfare* in 1998, like all other attendees, I was appalled at the growing problems of chemical poisons that seriously affect one-fifth of the people around the World, and am haunted by what to do to alleviate the medical problems from the viewpoint of mineralogy and geochemistry. Perhaps the best that can be done by a scientist like me is to present accurate factual observations and sober interpretations for ultimate social evaluation by cognizant human beings with appropriate managerial and political skills. It is easy to get depressed and think that many people will continue to produce too many children who will continue to be subject to negative environments, and end up in early death either from wars or pandemics. However, I am optimistic enough to believe that the problems will be recognized as facing the entire human race, and that ultimately there will be assignment of the correct actions by and for nearly everyone. Ultimately, physical scientists will be forced to develop a Hippocratic Oath for their behavior, but it will not be easy, as shown by the history for practitioners of medicine. The "*tragedy of the commons*" need not occur if positive steps are taken in the context of scientific research and government. Perhaps science academies around the world and action groups like the Environmental Protection Agency of the USA could get together to make short videos ~ 2 minutes long to be offered daily and freely to commercial television stations so that everyone watching would have their nose rubbed into the need to reduce the population and seek safe places to live. Otherwise the horrific living conditions in the underdeveloped world, and in slum areas of the developed

world, will continue to fester, and get worse. Even lowly-populated countries like the USA are beginning to develop significant problems from over-population, and a lower population is greatly to be desired.

In September 1951, my wife and I sailed for New York. The white bread and fresh fruit on the Cunard liner were a revelation after post-war austerity in both Britain and devastated Europe, and the acres of parked cars from New York to Washington signaled a "Brave New World." Three years of research at the Geophysical Laboratory of the Carnegie Institution of Washington opened my eyes to the exploding technical advances in geology, geochemistry and geophysics. Daily interaction with scientists from several countries, races and religions shook up the cosy ideas from Cambridge and England. It was a shock to find that black people could not go to restaurants and movie houses reserved for whites in direct violation of the US constitution; "shoving days" on streets and buses in 1953 marked a first phase of the civil-rights movement.

Two more years in Cambridge, England, and four years at Pennsylvania State University were filled with happy days of family life and scientific discoveries. I read casually about the explosion of H-bombs, launching of rockets, radioactive fallout, various kinds of pollution, civil-rights movements, and so on, but I did not join protest groups. My life became saturated with research, teaching and administration in the typical pattern of an active scientist. Busy people content with their life and work rarely become protesters, and this is one reason for reading this part of the book to see how I just got on with my work and did not start organizing. We must find ways to educate everyone about the geol/cosmo history, so that appropriate positive decisions are made in an overall context.

Joining the new Department of Geophysical Sciences at The University of Chicago in 1960 was critical to my later life. This pioneering department led psychologically by Julian Goldsmith was the first to integrate all the disciplines concerned with the earth and planetary sciences. At weekly seminars given by the faculty members we learned about rocks, fossils, planets, meteorites, weather, climate, etc. The Apollo 11 landing on the Moon in 1969 was just one of the major events in the Golden Age of Geological and Planetary Exploration. Now we can see the Sun and planets as one system set in a galaxy. In particular, there is a firm basis for understanding how life has developed over the past 4 billion years, and how it has been affected in general by climate changes, by impacts from comets and asteroids, and by volcanic action. Details, of course, will always remain controversial because of loss of information. The old parochial subjects of paleontology, geology and meteorology have been swept up into the new synthesis, and we can see how the future of the human race depends on establishment of a harmonious relationship across the world. My work on the origin of the Moon, meteorites, and early rocks of the Earth automatically took me through the whole gamut of studies of the solar system. On a smaller scale, my observations of the flora and fauna of the Indiana Dunes State Park & National Lakeshore, and many other places in the Mid-West, during family picnics and student field trips, brought me to a technical understanding of small-scale ecology that reinforced and extended the instinctive insights from my parents.

The specific event that led to this book was my reading in 1982 of the special issue of *Ambio* on Nuclear War. I knew about the devastation at Hiroshima and Nagasaki and about the build-up of nuclear weapons, but I was thunderstruck to find that about 50,000 advanced warheads had been built. Every scientist and engineer has abundant evidence for Murphy's Law that anything that can go wrong will go

wrong. To believe in the long-term safety of deterrence by Mutual Assured Destruction required complete disregard of the whole history of technology. Furthermore each nuclear weapon violates two basic ethical concepts: military operations should not be larger than necessary to attain civil goals, and military actions should minimize civilian casualties.

I checked the scientific and technical statements in the *Ambio* issue, and accepted the conclusions that up to one billion people could be killed in a few days during a major "nuclear exchange" - note the typical use of a friendly word for a dreadful event. Furthermore I noted the suggestion by Paul Crutzen and John Birks that black smoke from burning cities and forests might drift around the whole Earth and blank out the sun. This suggestion triggered off a flurry of studies, and Richard Turco invented the emotive concept of "nuclear winter." Although it now appears that early predictions from the simple scientific models may be too dismal, it is quite plausible that wild weather and significant climate changes would make it difficult or impossible for many of the immediate survivors of a nuclear war to survive the next few years, simply because of lack of food. God help us if the current scientific and engineering uncertainties are resolved by observations of an actual nuclear war - assuming the disputants survive.

In May 1983, Tom Ahrens of the Public Affairs Committee of the American Geophysical Union asked me to organize a session at the December meeting in San Francisco on The Geophysical Consequences of Nuclear Explosions. The speakers came from an international study group of distinguished scientists whose work has led to the Conference on the Long-Term Worldwide Biological Consequences of Nuclear War (Washington/Moscow, October 1983) and to the report (1985) of the Scientific COmmittee on Problems of the Environment - Environmental Effects of NUclear WAR of the International Council of Scientific Unions of the United Nations Educational Scientific and Cultural Organization. I became very depressed as I read the preliminary reports, and found it necessary to switch off several times because I was becoming obsessed by images of burning cities and broken bodies.

In order to check the scientific predictions, I started to look at geological and atmospheric events that had produced related phenomena. It was a revelation to find that an impact of a *large* asteroid or comet might be more destructive than a nuclear war; the term "impact winter" has been proposed. Of course, the chance is very small (on the million-year time scale), but it is not zero, and we do not know when the next big impact will occur. All recent volcanic eruptions have been small to medium, but huge ones have left their traces in the geological record; further large ones must occur, and the dust and sulfur-rich droplets might produce a "volcanic winter" that would harm agriculture around the world.

Joseph B. Knox of the Atmospheric Sciences Division of the Lawrence Livermore National Laboratory (a major weapons laboratory associated with Edward Teller) invited me to give a seminar in February 1984 on the relation between hazards from nuclear war and natural events. We and other scientists talked informally about what could be done to guard against natural hazards if the huge resources of the military programs could be transferred. In particular, some of the technologies of what became the useless Strategic Defense Initiative (Star Wars) would be relevant to monitoring volcanic eruptions and protecting the Earth against impacts - indeed, the general outlines of the technological defenses against natural hazards had been discussed in technical papers going back as far as Project Icarus at MIT (1967).

Joseph Knox invited me to present a paper on natural hazards at the Fourth International Seminar on

Nuclear War at the ancient military town of Erice perched on a steep hill in Sicily. This seminar in August 1984 was one of the very few meetings at that time between technical representatives of the nuclear powers, and the organizers, A. Zichichi and his wife, were able to get around the problems of formal diplomatic representation. Although enjoying the splendid hospitality, I was appalled by the psychological incompatibilities of the participants. Delegates from California presented the technological concepts of SDI/Star Wars with a naïve inaccurate optimism (originally planned for a flat Earth until I pointed out that it was spherical) that contrasted with the dour secretiveness of the Russian delegates. The speakers from several countries in Western Europe gave detailed papers on military and diplomatic planning; the underlying pessimism reflected the many centuries of suspicious negotiations that have not stopped destructive wars. There was little meeting of minds, and the righteous statements of goodwill in the final report were a mockery of the tense exchanges between representatives of the USA and USSR.

During the years after this conference, I have been trying to find time to compare all the hazards that face us. There is a huge literature on hazards and catastrophes, but most books are highly specialized and do not consider the big picture. The more I read, the more I became convinced that all dangers should be considered in relation to each other. For example, it makes little sense to worry about big volcanoes and asteroids if a full-scale nuclear war is just around the corner. Furthermore, it turns out that appropriate reduction in military expenditures could allow beneficial development of programs for defense against various natural hazards. In an even broader context, natural and military dangers must be considered in relation to medical problems, especially those related to food supply and population growth. All of these items are related to energy supplies and modifications of the earth's surface and atmosphere. And finally, all the scientific and engineering aspects must be set into an ethical framework. We must consider the aims of life if we wish to decide on ways and means of prolonging it.

In 1988, I was asked by the University of Chicago to set up a facility at the Advanced Photon Source of the Argonne National Laboratory, and over the next 15 years the Center for Advanced Radiation Sources has developed nicely into a 100 million dollar set of 3 sectors for application of X-rays to: structural biology; chemistry and material sciences; and geo-soil-environmental sciences. Unfortunately, this turned me effectively into a full-time businessman as I hunted for money. However, I was encouraged to read more widely, and in particular I became involved in the toxic elements that affect the health of so many people around the World. Retirement last year has finally allowed me to put together this book, after several years of delay. Every day I think of some new angle. But no-one has yet to jump up and down and say he/she will devote his/her life to educating people to the overall dangers. I hope that this will occur soon, and also that politicians like Al Gore will be able to organize international support. For the USA, it is quite clear to me that it should reduce military actions abroad, and concentrate on quiet steady planning to reduce its population and improve the quality of life. I am aware that many groups are getting together to consider such important things such as the melting of the ice-caps, but I have not seen evidence yet of any group getting together to look at the nitty-gritty of social tensions involved with the absolute need to lower the world's population, and move onto the best places for overall safety.

So please join me in this search for possible overall answers to the problems of the next century and millenium. See how I developed from a farm boy with an instinctive feeling for the unity and continuity of life to a research scientist haunted by a technical knowledge of the dangers that might face us. I hope that you will join me emotionally as well as intellectually in this search for a stable future for all mankind. Let love and humility be our watchwords as we stumble forwards to a better and safer future for all citizens of this one and only home. Let us leave a better world for our own grandchildren and every grandchild around the World.

Part I

Farmer's Boy to Research Professor

An Exploration of Nature

A scientific autobiography set in the context of world events. An aim of this section is to show how I learnt how to live in an old-world country and then fit in a new world, and how history is important and hard to forget.



Chapter 1

Smith Family Robinson

My father, Henry Victor Smith, born on November 27, 1897, in Roe's Lane, Crich, was the eleventh out of twelve children born to Joseph Roe and Annie Elizabeth Smith. Ten children survived to adulthood and contributed to the population increase of the late nineteenth century. Henry was born at the



Henry V. Smith and his sons Tom, Frank, and Joe.

End of Queen Victoria's reign, and his second name (also given to me) symbolizes the patriotic fervor of the Victorian era.

Joseph Roe Smith's family came from Kelstedge near Ashover, where his old smithy on the Matlock-Chesterfield road was recently converted into a teashop. JR's father was a special constable who brewed and sold beer at the Greyhound pub (now pulled down) in Roe's Lane, Crich: saltpeter and tobacco were added to increase thirst and promote more sales. Fighting was common and JR bounced many customers. JR was an entrepreneur who converted a defunct chapel into a workshop. Oak trees were cut down with a two-handed crosscut saw, brought to Crich on a horse-drawn limber, and sawed into plants. As a young man without seniority, my father was inevitably in the sawing pit with dust and oil dropping over his arms. Oak planks were cut and shaped into coffins, each

fitted neatly to the corpse. Wagons were made from various types of wood. Ash was particularly important for the wheel-spokes because of its uniform coherent texture. For days my uncle George trimmed the pieces for each wheel: fitting the hot iron rim at George Haslam's smithy was always an anxious time as the metal shrank around the wood.

Essentially my father was a child of nature with an encyclopedic memory filled with all the country lore that circulates in a community of farmers, miners, quarrymen and local tradesmen. Much of his experience would match that of Alison Uttley, who was born in 1884 at Castle Top Farm three miles northwest of Crich on a gritstone shoulder overlooking the river Derwent. Her book, *The Country Child* (1931), describes the yearly cycle of farm life with all its joys and fears - especially fears from her overactive imagination. The yearly visit of the Irish laborers for the harvest is also listed by H. Rider Haggard in his account of agricultural and social researches in *Rural England* (1906). I remember vividly the good fellowship of communal work in the hay and corn fields in the thirties and forties before the tractors, balers and combines exerted their mechanical control; by then, the Irish had been replaced by off-duty coal miners with new-found shorter hours or unemployment. The old names still survived: straddle (base of a stack), tedder (machine for tossing hay), cock (small rounded stack in field for temporary protection from rain), and dray with gormers (wagon with crossbars at back and front).

Pigs were still killed on the farms in the forties. After the pig's throat had been cut, and blood saved in buckets, the meat was cut up into flitches of bacon and haunches of ham to be salted down in the cellar. Everything was used including the trotters. Chitterlings and brawn were delicacies. Rabbits were hunted avidly, preferably with wire snares and ferrets rather than guns. Off-duty miners were particularly fond of their ferrets and homing pigeons. Ultimately, the rabbit population crashed when myxomatosis was deliberately introduced into Britain in the 1950's and farmers moved infected rabbits into uninfected regions. After dropping to nearly zero, the rabbit population would slowly increase until another wave of die-off began. Wood pigeons were a menace, and I would climb trees to take out their nests.

Many people relied on Old Moore's almanac for planting times; the phase of the moon was particularly important. A wide range of vegetables almost covered the year (spring cabbage, forced rhubarb well primed with horse manure, lettuce, radishes, cress, early potatoes, peas, various beans, carrots, parsnips, onions, leeks, brussel sprouts, main-crop potatoes, turnips). Domestic fruits (apples, pears, various plums including damsons, various currants, cherries, raspberries, strawberries) were supplemented by wild ones (blackberries, bilberries, hazel nuts). Many types of wine and gin were brewed, including cowslip wine and sloe gin. Teetotalers would imbibe these alcoholic drinks because they were natural - on holiday nights, my aunt's eyes would brighten up after a wine or a gin, and all sort of gossip would appear. Field mushrooms were common, but are now rare because of the use of fertilizer on the grass. The wide range of foods offered considerable but not complete protection against weather extremes.

In general, the Derbyshire climate of the twentieth century was excellent for gardening and farming with a fairly even distribution of rain over the year, few droughts, and not many extreme winters. On average, the temperature has been about 1° C above that of the Little Ice Age (AD 1400-1800), but somewhat below that of the benign years of 1100-1300. The overall trends hide considerable year-to-year excursions, including very cold winters in World War I and warm summers of World War II. Of course, the

Derbyshire natives usually complain about the dull wet weather, and weekly package tours to the sun-drenched Mediterranean and Iberian beaches have become popular.

Life was certainly tough in central Derbyshire during the early twentieth century, but social tension was probably less than that between landowners and farm laborers in Suffolk described by Ronald Blythe in *Akenfield: Portrait of an English Village*. Probably the complex mix of small farmers, laborers, miners, quarrymen, factory workers and tradesmen mitigated the social tensions in Derbyshire. Many people had more than one occupation, unlike those in Akenfield. In eastern Derbyshire and western Nottinghamshire, the mining villages and pit heaps almost squeezed out the farms. However, miners retained a love of nature as typified by Walter Morel, the father of Paul Morel, in David Herbert Lawrence's autobiographical novel *Sons and Lovers*. The dangers of working in the narrow faulted and gas-filled coal seams brought out an intense comradeship that only occasionally broke down into ugly fights under severe provocation or excess alcohol. Many miners became my friends as we worked in the hay fields, and a coal miner, Harold Platts, was my father's pal from boyhood to old age. Since my schooldays, the old pit heaps have been leveled and grassed over, and the evidence of mining is not so obvious. At Pentrich and elsewhere open-cast coal mining was popular after WWII, and the neat but boring pattern of fields is the result of later leveling. [The situation never became as bad as in the Appalachian mountains of West Virginia and Pennsylvania where big coal companies took off the tops of hills.

My father learnt to read, write in copper-plate, and do simple arithmetic at the village school, but wrote only necessary business letters in his later years, checked by my mother for correct grammar and spelling. Upon leaving school at 13, he began working in the businesses operated by his father and elder brothers. His cloistered apprenticeship to life was soon to end as he was catapulted into a maelstrom.

World War I followed the murder of the Austrian Archduke on June 28, 1914, and Britain entered the war on August 4, 1914, after German troops invaded Belgium to outflank the French army. In Britain there was an initial rush to volunteer as a patriotic fever spread over the country. Passions were inflamed with exaggerated and partly false tales of German atrocities in Belgium; of course, violation of Belgium's neutrality was a serious breach of international law and the German army killed many civilians. Historians wrangle about the causes of the war, and I cannot pretend to match their expertise. Undoubtedly there was stiff-necked national pride and a competition to build profitable empires. Undoubtedly there was a collapse of the social structure of the old alliances in central Europe. Undoubtedly there were standing armies and navies ready to obey orders to attack, and large industrial complexes ready to make further profits from lethal weapons. Undoubtedly there was a lack of overall good sense and a failure of negotiations, just as there is so often today. Surely all of the leaders misjudged the consequences of their actions. They seem little more than mindless cogs in a machine doomed to shake itself to destruction. But once the armies rolled, it was too late for the decent people like my father. They were swept up as psychological pressures encouraged volunteers to replace the slain and maimed of the original standing army and early volunteers; conscription was ultimately enacted.

Uncle Joe was deferred to look after Cross Farm in Crich (rented incidentally from the Butterley Company; this ultimately turned into a conglomerate that owned most of the Falklands/Malvina Islands and profited from billeting troops in the war with Argentina). Uncle George stayed with the woodworking

business, but Uncle Norman and my father went to France. Norman, a handsome graduate of Wirksworth Grammar (High) School, was gassed and captured in a trench, and just survived starving to death as the Germans ran out of food in 1918.

My father took King George's shilling on December 29, 1916. Fortunately for him, his skill with horses was recognized and he became a signaller in the Royal Corps of Engineers rather than a rifleman or grenadier in the trenches. He was always reticent about the details of the war, except with regard to the brutal conditions of crude survival in tents during the bad winters of 1916-8. The horses had first priority. Food was short (sometimes 6 men to a loaf for the day), cold and sometimes bad. Near the trenches, dead men and horses disappeared into the mud. Axes were used to break ice. He and his pals strung the wires at Ypres (known as Wipers), and rarely questioned why they were in France. Collapse from shell shock was commonly treated as cowardice. Conscientious objectors back in England were despised as craven rats. Only a few officers of the British army questioned whether the war was justified, and whether a demand for unconditional surrender was necessary or wise.

My father admired the German soldiers for their courage and skill. Indeed, the professional direction by skilled officers was also evident in WWII where a three-fold larger group was needed by the mostly amateur western armies over the professional opponents. [Only in recent years have I been able to read the German literature, and find that there was the same skill at poetry writing by German officers as for British ones.] My father looked down on the French soldiers for the mutiny that occurred; he did not recognize that the French people had been worn out psychologically and physically by lost wars and social chaos during the past century, and that their present army had suffered more grievously than the British one. No doubt there were some good times, as evidenced by his singing of "Mademoiselle from Armentières - Never been kissed for forty years. Inky pinky parlez vous," "Pack up your troubles in your old kit bag" and so on. He kept away from loose women unlike some soldiers.

My father was lucky but many Crich men were not. The war memorial at the church records 63 dead or injured from a total population of about 1,000; three brothers named Curzon stayed under the French poppies. The total casualties of 8.5 million dead, 21.2 million wounded, and 7.8 million prisoners and missing out of 65 million combatants constituted a tragedy which produced a universal resolve that this was to be the last war - The War to End All Wars.

Prospects for the demobilized soldiers were poor. My father stayed on, and was billeted as part of the Army of Occupation in the Cologne (Köln) region of west Germany. He got on well with the individual German people, and worked with them to get in the harvest.

When my father returned from the War, he faced a job market savaged by unemployment and underemployment, in spite of the war dead and continued emigration. While the rich Bright Young Things flapped in London, the laborers and even the middle class struggled in England, and especially in east Europe. Unemployment in Britain rose to 17% in 1922, dropped to 11% and then went up to 22% in 1932.



Crich was relatively stable as the mixed agricultural-quarrying-factory economy adjusted to peace. My father worked as needed by his brothers, and chauffeured his father's car. A round trip to the seaside resort of Blackpool was an adventure without modern roads. During this dodging around, my father wanted his own farm, but how could he get started? He almost migrated to Australia on a sponsored program. He walked out with several girls and was almost married to a mill girl from Holloway. Fortune finally favored him when he met my mother.

Edith Robinson was the second of three daughters of Thomas and Annie Blanche Robinson from Snapes Farm, Kirk Langley, in the rich glacial deposits of South Derbyshire. This tip-your-hat-to-the-squire region is still a secretive land of small farms and rich estates with only a few gravel pits and cheese factories to disturb the bucolic air. However, weekenders are doing up the old cottages, and my mother's birthplace at Mercaston

Brook is now tarted up into a rural retreat.

A lively intelligent girl with sparkling eyes, Edith obtained a Certificate from Derby Teaching College. Her first job was at Crich School, and she became friendly with William Leese from Shropshire, then headmaster of Fritchley School, and his wife-to-be, Dora, the youngest sister of my father Henry. According to Dora, "It was love at first sight. A farmer's daughter and a teacher; my father and mother were pleased." This brings us up to June 8, 1927, when my parents were married at Kirk Langley.

Chapter 2

Home on the Farm

1928-1945

After a brief spell at a small croft on The Common, Crich, where I was born on 30 July 1928, my parents rented Barn Close Farm, Fritchley, in 1929. My father bought stock and implements with the 600 pounds



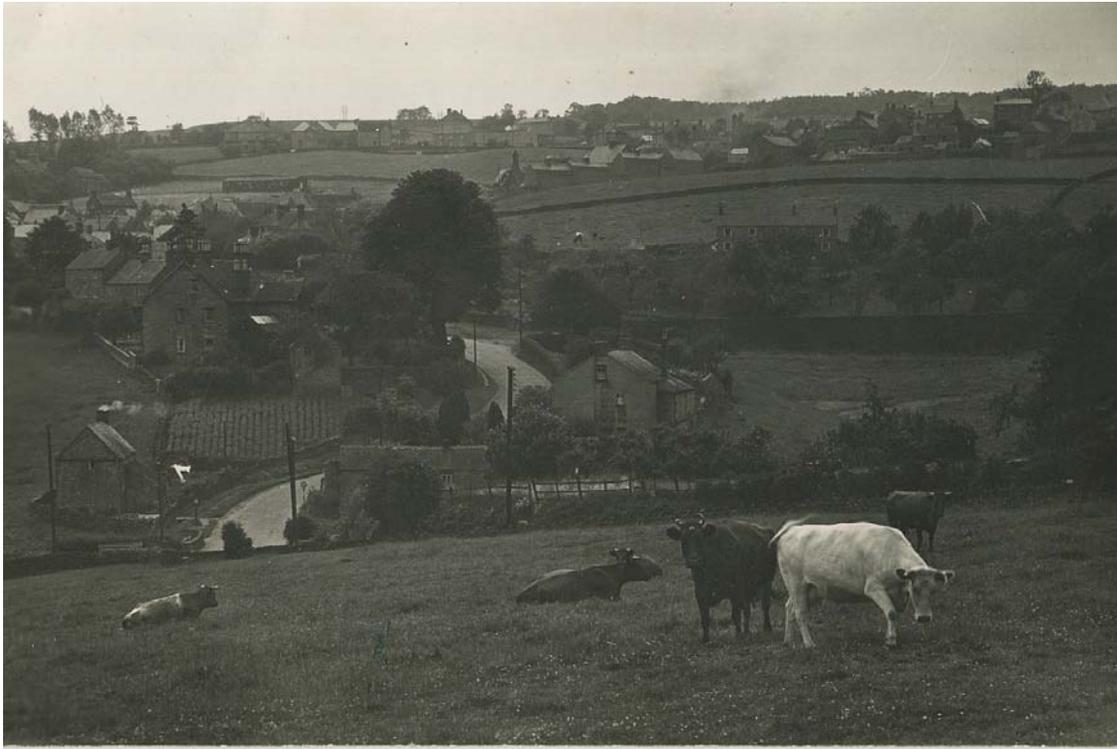
saved up from his soldier's pay. My mother was forced to give up her job as teacher. It was a tough battle for my father and mother because the farm was semi-derelict from long neglect by an unusually idle Quaker. Henry burnt the corn crop the first year because it was choked with weeds. To obtain cash, it was necessary to milk cows in the early morning to get the milk on the 6 AM train to Sheffield. As a small boy, I went with my father to Ambergate railway station in the float pulled by the mare Dolly. It was delightful on dry summer mornings, but a real pain on winter mornings as Dolly struggled up and down icy hills on her special studded shoes. All the farmers were having a rough time as cheap food flooded in from abroad. It was especially bad for my father because he needed to build up stock and

Joe (right), his cousin, and grandmother. implements. Most of our food came from the garden, well fertilized by

cow and horse manure, and a weekly delivery from the grocer supplied other needs: sugar, flour, treacle, spices, yeast, etc. Bread and cakes were baked in the oven. Fruit pies and suet puddings finished each midday dinner. All clothes and shoes were worn to the limit, patched as necessary, and passed down the family; probably my twisted little toes result from wearing tight shoes too long. Burlap bags protected us in the fields from heavy rain.

All fuel came from the farm except for several tons of coal to power the range and back boiler, a few gallons of paraffin (kerosene) for the kitchen lamp and storm lanterns, and some candles to light us to bed. We used hot-water bottles and heated bricks to take the chill off the bed sheets in winter. On really cold nights the urine froze in the chamber pots.

Two draft horses pulled the carts, plough, mowing machine, self-binder and other harvesting machines; it was touch-and-go every year to feed them up in slack times so that they did not fade away in the hard periods. Decisions were endless especially when the weather was unsettled, as it often is in Derbyshire. The strict enforcement of the Sabbath, except for necessary work like milking and feeding the cows, was a welcome relief from the 12 to 16-hour days.



View from Barn Close Farm towards Fritchley from an old postcard.

One really bad year and my parents would have been finished. They survived, but only just. A brutal blow was an attack of foot (hoof)-and-mouth disease in 1936. By bad luck, my father bought an infected cow at Derby market. The next day the tell-tale symptoms (viral blisters in the mouth with characteristic smacking of the lips) were spreading from cow to cow in the shed, and the Ministry of Agriculture team moved in. All the cloven-footed animals were shot and burned in a great pyre whose stench flooded the farmhouse. We were quarantined for several months. The compensation was fixed by law at a level sufficient to replace the herd, but not at the same quality. So back to searching for under-priced cattle at the market, breeding with a good bull, picking the best calves, and inching upwards each year.

On the whole, it was a great life for the children on a thirties farm. So many jobs were within a child's capacity: feeding the animals, collecting eggs, making haycocks, hunting for sticks and broken branches, lighting fires, planting and harvesting in the garden and on the farm, taking a horse to the smithy for new

shoes, fetching up the cows for milking, delivering potatoes to the village, and so on. By the age of fourteen, a farm boy could almost match a man in strength but not in endurance. There was never a dull moment. The birds sang, and the fields were full of flowers and butterflies.

Market days were special. The Friday cattle market at Derby brought farmers in from southern Derbyshire, and cattle dealers from as far as Scotland. Local cattle were picked up in early morning by trucks (lorries), and placed in order of sale by a ballot. The farmers would arrive in midmorning after completing the milking and mucking-out. After inspecting the pens, and checking the auction rings with the hypnotic fast talk of the auctioneer, they adjourned to the Corporation Hotel for Irish coffee. I stood outside, huddled in cap, scarf and overcoat, stamping up and down to warm chilblained feet, and fascinated by the endless stream of farmers. Eyes were brighter, noses redder, and voices louder as the farmers came out of the bars. Bargaining might go on for hours with gradual lessening of the difference in asking and offering prices. Finally honor was satisfied by three PM as a bargain was struck with half-a-crown or five bob for luck from the seller to the buyer. After a year or two, I could predict the final price after judging the emotional intensity of the original sparring; I think the bargainers could too, but needed the sport. So back home with farm supplies such as twine made in Dundee from Indian jute; occasionally a new pair of boots. Tea time, milking the cows, collecting the eggs, reading a book, and off to bed with dreams of "How much am I bid for this strong heifer from Mr. Birkinshaw? Who will start me at ten pounds? Nine. Thank you. Nine, ten, eleven, eleven, eleven, eleven ten (i.e. eleven pounds ten shillings), twelve, twelve, twelve. Come on gentlemen. Twelve five, etc. Going once, going twice, twelve ten, etc. Sold to Mr. Calderbank".

As the years went by, more and more of the market space was taken up by new machines painted in brilliant colors, and less and less by horses. More farmers rolled up in cars instead of traveling by bus. The Industrial Revolution was rapidly moving into the British farms in the thirties, and most of the simple handwork was gone within twenty years.

A farm boy learnt to take death as part of the inevitable course of life. The pet calf went to market. Rover, the old collie, was run over, but Jill, the pup, took his place. No matter what happened, the cows must be fed and milked, rain or shine. Danger is always lurking around the next corner, but make the most of today. Did you hear about John: the bull caught him in a corner and was ready to finish him off when Joe drove the bull off with a pitchfork. Did you hear that Eddie was run over by the tractor when the clutch slipped as he was hooking on the plow? The Good Lord helps those who help themselves. My mother suffered a fractured skull when knocked down by a cow whose calf was being taken away; she spent several weeks of convalescence in bed.

A severe trial was the numerous illnesses. Measles, chicken-pox, mumps, whooping cough, diphtheria, scarlatina and polio were ubiquitous, and the only vaccination was for smallpox. Only some milk was pasteurized, and tuberculin testing of cattle had not begun. TB was a serious killer of young adults. Dripping noses and chilblains were the inevitable consequences of winter cold and bad air. Influenza epidemics were erratic - the 1918 pandemic killed tens of millions, including my Aunt Mary, and



Joe and his younger brother Frank feeding a lamb on Barn Close Farm.

the death toll of half-a-million was four times greater than the number of war dead. Although immediate deaths from these illnesses were becoming fairly small in the thirties because of better nursing, some survivors had been weakened and paid a penalty later on as a fragile heart or body brought on early death.

To bring my family record up to 1945, I attended Fritchley Church of England School from 1933 to 1938, transferred to the Herbert Strutt School, Belper, with a County Minor Scholarship, and went to Gonville and Caius College, Cambridge University, with college, state and county scholarships in 1945.

I was fortunate because my mother and uncle Bill Leese encouraged me at school. An Arthur Mee's



Joe's Aunt Dora (Smith) Leese and her husband William Leese.

We learnt the names of all the red patches on the map during the yearly Empire Day celebration of May 24. In retrospect, I conclude that we had been brainwashed with the God-given virtues of the British Empire. Then we were too young to appreciate the complexities of the good and bad aspects of imperialism and wore the medals and waved flags with enthusiasm.

After taking the usual wide range of subjects in the early forms (grades) at the Herbert Strutt School (a gift from a descendant of Jedediah Strutt, the mill owner), it was necessary to choose Arts or Sciences for the Sixth Form. There was no TV and little radio (restricted because expensive wet and dry batteries were needed on the farm); hence I read most of the books in the school and county branch libraries on just about every subject. My Uncle Bill took the Spectator and the Times Literary Supplement whose erudite articles puzzled me for some years before I gained enough background.

As the only candidate from Strutt School for the Cambridge Entrance Examinations, I was given a key to the science textbook cabinets and told to get on with it. Systematic working out of the examinations since 1914 brought me up to speed; incidentally the mathematical questions seemed tougher in the earlier years. The journey to Cambridge for the scholarship examination was a real eye-opener. For the first time, I saw flat country with large fields of wheat and barley, and few or no animals. I was walking on stones trodden by Newton, Thomson and Rutherford. My competitors came from famous public schools such as Eton, Harrow and Winchester and long-established grammar schools. The country mouse was awed but not intimidated.

Encyclopedia was invaluable, though somewhat quaint for modern tastes. Daily chanting of multiplication tables and word spellings hammered in the rudiments at the Fritchley school. I can spell almost any word without checking a dictionary. Nature walks and lessons on local history were fun. Bible readings from the King James translation developed a feeling for English style.

Chapter 3

Derbyshire, My Derbyshire

Derbyshire, in England, is a great place to see the historical development of modern society. Ancient forts and stone circles survive in the hills; some of the first water-driven factories are still present in the valleys; and the latest industrial and agricultural advances can be seen within a few miles. The social changes are indicated by the surviving records and buildings. If you look in these places you can imagine how the dangers have changed, and you can start to guess at the future problems that are the ultimate subject of this book. However, it is important to recognize that Derbyshire displays only some of the evidence on the dangers to the human race. Consequently I shall use world-wide scientific knowledge to enrich the narrative with appropriate comments.

James Herriott's Yorkshire is just north of the county of Derbyshire (pronounced Darbisher), and his crusty characters can be matched with the sons of the soil from my farming days. However, he did not deal much with the mining and industrial workers who play such an important role in both Derbyshire and Yorkshire.

The local geology and climate of Derbyshire are critical to the uses of the land. As the Pennine Chain of sandstones, shales, limestones, coal measures and basalts dips southward into the glacial deposits of sand, clay and gravel, the peat and heather moors give way to challenging hill farms and finally down to the

rich water meadows of the Derwent and Trent valleys. Cloud and rain are frequent in the north, but the rare sunny days reveal a fabulous panorama of sandstone edges and limestone cliffs looming over the dry dales and U-shaped river valleys scooped out by glaciers. Tilting, faulting, slumping and erosion produced a delightful variety of scenic charms. Even sheep have a rough time in snowy winters on the northern moors, which are often reserved for grouse by the shooting gentlemen. Cloud and rain are also frequent in the south, but the higher temperature produces favorable conditions for cattle and arable crops. Over the past half-century, the climate has moderated allowing an extra two weeks of growing season.

The river valleys and shoulders were almost completely filled with small farms (50 to 200 acres) between the many industrial towns and villages. The limestone rocks are riddled with deposits of lead minerals, fluorspar and baryte. To the east, the coal measures were exploited in the Industrial Revolution, along with ironstones and clays that are still used in a conglomeration of dirty towns which spill over into Nottinghamshire and Yorkshire. Water powered the first factories. Textile and railway shops pioneered the way for high-tech companies including Rolls Royce.

Late Paleolithic people settled on the well-drained limestones. Stone circles (Arbor Low, Nine Ladies) and cists, together with walled fortifications (Mam Tor, Carl Wark), testify to well-organized communities with religious and military concerns. The wet lowlands and the forests (including Sherwood Forest in Nottinghamshire) were not comprehensively developed, but early man was already using fire to make clearings suitable for agriculture. Iron, bronze and pottery remains in Derby Museum demonstrate a growing technical competence.

The Roman conquest two millennia ago produced new settlements and a network of roads and bridleways, but most of the battles at the time of Boudica were further south. Lead ores were exploited at Crich, Wirksworth, and elsewhere; to what extent lead poisoning enfeebled the Romans may always be debatable. Hot springs were used for baths at Aquae Arnemetiae (Buxton). Vases of Derbyshire Blue John (fluorite) were buried at Pompeii, near Naples, by volcanic ash from Vesuvius. Ecological changes were probably still small, but big game was exterminated.

The Anglo-Saxon invaders established many new villages (e.g. Darley, Wensley) in forest clearings during the sixth to ninth centuries A.D. Many funeral barrows survive. There are lovely stone crosses with knotwork, scrolls and religious scenes (e.g. at Bakewell church). A tenth-century crypt with spiraled columns survives at Repton, though the monastery was destroyed by the Danish invaders. Probably the inaccessibility of the Derbyshire hills saved most of the Saxons from the Danish invaders who ultimately withdrew; however, Derby comes from the Danish *Deoraby*. Easier access to Herriott's Yorkshire resulted in many surviving Danish settlements with give-away name endings (e.g. Kirby and Masham). It is difficult to estimate the ecological changes of this era, but they must have been minor compared to those of the last century.

The climate (temperature, rainfall, etc.) determined the type of farming; oats for example matures faster than wheat, but is more prone to wind damage. By 1900 AD, 490,000 acres out of 610,000 non-mountainous acres were cultivated, 450,000 by tenants and 40,000 by owners. Only 26,000 acres of woods remained. Cattle (140,000) had surpassed sheep (130,000) and pigs (30,000) in order to supply milk, meat, butter and cheese to the towns and cities. Power came from 30,000 horses. The major crops were oats

(700,000 bushels), wheat (500,000), turnips (137,000), mangolds (100,000), potatoes (18,000), and hay (150,000 acres). Mowing machines were in general use, and American-made binders were hired out. Steam-driven threshing machines had not quite wiped out flails. Free trade and cheap imported food were urged by city dwellers. Farm laborers became scarce as mines and factories expanded.

How did climatic changes affect the agriculture? Absence of records of overall famine suggests that the mixed farming was able to accommodate the long-term changes from the balmy conditions of the eleventh century through the Little Ice Age of the sixteenth and seventeenth centuries to the improving conditions of the nineteenth and early twentieth centuries. However there must have been temporary problems, especially in 1615 when no rain fell from March 25 to August 4. Slaughter of cattle, run-down of hay stocks, and a coarser human diet, probably were the major responses. The 1816 "Year Without A Summer" in New England and W. Europe is well known, and is now thought to result from cooling caused by the volcanic dust cloud from the Tambora volcanic eruption of 1815 in Iceland. Poor crops and consequent high food prices in the cold wet year of 1816 (last snow: June 7) helped to fan social discontent already growing after the Napoleonic wars. Jeremy Brandreth's march of indigent laborers from Pentrich to Nottingham in 1817 was crushed, and he was hanged and beheaded; quartering was remitted by the Prince Regent. Derbyshire's diverse social and agricultural systems prevented great famines like the Irish one of 1845-9. Emphasis on the potato, which succumbed to an infection, and the callousness of the social structure, coupled with little or no birth control, exacerbated the disaster in Ireland.

Industrial activity goes back to the Stone Age, and it developed by the Middle Ages into a variety of local trades. Lead mining is one of the best known, but has now been almost entirely replaced by mining for fluorspar (calcium fluoride, a flux) and baryte (dense barium sulfate, needed for oil drilling). Unfinished millstones still lie on the moors. Water- and wind-mills ground corn and bones. Iron and steel were produced with the aid of charcoal, with consequent denudation of the forests. Coal was produced first from bell pits (60,000 tons in 1550-1600 AD). Near-surface pits were still operating in 1945. The rapid development of deep pits in the nineteenth century resulted in the production of 10 million tons per year by 1900. Natural gas from the North Sea, and cheap coal from abroad, has essentially wiped out the UK coal industry in recent years. German engineers came in the sixteenth century to develop drainage of lead mines. Large and small engineering companies are now found throughout Derbyshire. Transport by packhorses driven by jiggers faded away as turnpikes were built in the eighteenth century. Now huge limestone quarries supply road metal for the new motorways, and lime-kilns belch out noxious smoke.

Of great importance for the present ecological state of the world was the development of the factory system for producing textiles. Hand knitting came in from Europe in the sixteenth century, and silk spinning from Italy. Various inventions improved the efficiency of hand work. The Derby Rib stocking frame was developed by Jedediah Strutt in 1758, and home workshops proliferated in villages around the major towns. George Sorocold developed water-power engineering. The seminal move to the modern factory system came from the partnership of three ambitious but high-principled men. A Lancashire barber



A view of Crich, an old lead-mining town. Crich Quarry is in the background.

and wigmaker, Richard Arkwright, patented a water-frame roller spinner in 1769, and Samuel Need and Jedediah Strutt supplied business expertise. Critical to success was development of a fireproof cotton mill with an iron frame, stone walls and ceramic floors. Water-powered factories still survive at Cromford and Belper. Although the hours of work were long by modern standards, and young children were employed, these pioneers must be praised for providing high-quality housing (Long Row, Belper; North Street, Cromford), schoolrooms in the factories, and model farms (e.g. Moscow Farm, Milford) to supply dairy products and vegetables. Because the workers were used to the informal hours of farming, mining and quarrying, it was necessary to discipline them with overseers who levied fines. There are many worse places in the modern world than these early factory communities.

The Industrial Revolution was now well underway with all its good and bad aspects with which we are so familiar. In Derbyshire, the population increased four-fold from 162,000 in 1801 to 620,000 in 1901 AD as the industrial towns grew. Simultaneously, many people emigrated to America and British colonies. Whereas the death rate was usually greater than the birth rate in early towns, with the deficiency made up by immigration from the country, the later towns had better hygiene and fewer deaths. A slower growth rate in the twentieth century as families became smaller for a variety of reasons increased the population by about one-third to the present number of about 850,000. In spite of the near-stability of the present population, new houses, factories and roads are still eating up land as the material standard of living continues to grow. Consumption of fossil energy was trivial up to the nineteenth century, but has grown enormously as coal and then gas and electricity were used to heat and light homes, and as petrol-burning

cars began to fill the roads after 1950.

With this background we can look at the various dangers that faced my predecessors in Derbyshire.

What were the medical hazards? Records are essentially absent until registers were kept in the parish churches, and even then the causes of most deaths are conjectural. A few people attained or surpassed the Biblical limit of 70 years, but most succumbed as children or young adults to a variety of diseases; weakness from poor food and exposure to cold must have greatly reduced the chances of survival from any attack. The bubonic plague, smallpox, and several other diseases ravaged the population on many occasions; for example, 259 people died out of 350 at Eyam from bubonic plague in 1665. Smelting of galena into lead produced noxious fumes that extended the contamination around lead veins. Cattle died from lead poisoning ("belland"), and some contaminated fields are still fenced off. Silicosis killed needle grinders in ten years until 1843 when the grindstones were wetted. Lack of iodine in some waters led to goiter with the characteristic Derbyshire neck. Smoke was probably bad in the hovels, but industrial smoke pollution did not become severe until the nineteenth century. Food poisoning may have been serious, especially in late spring and early summer before the decaying supplies were replaced by a new harvest. Village dullards were common when I was a boy, and genetic problems from inbreeding were probably more prevalent in the Middle Ages. Many people were crippled or killed by accidents in the mines, quarries and farms, and medical techniques were of little help until the present century.

When I was a boy, one went to the doctor only for a severe emergency such as a broken bone or very high fever. The only vaccination was for smallpox. If food was dropped on the floor, you were expected to pick it up and eat it. I remember my father saying "You got to eat your peck of dirt." I had a continual series of fevers that fortunately went down within a few days. Contagious abortion of cows was one problem. Skin diseases from animals were picked up. Chilblains were the natural consequence of cold feet in unheated homes. Shortage of vitamins, iodine and various trace elements was typical. As a young girl Florence Nightingale tried to help members of the lower classes, but was put off by her parents. Until the National Health Service was started after World War II, life was hard and brutal for most people in the United Kingdom.

How about the danger from wars? Because of its hills and remoteness from the sea, the inhabitants of Derbyshire were spared the direct horrors that afflicted central Europe and Russia. Presumably there were times of terror as new invaders entered England, but most of the time was probably tranquil. The Saxon king Harold drove off the Viking Harald Hardrada at Stamford Bridge (Yorkshire) on September 25, 1066, but his army, exhausted after a forced march, succumbed to Duke William of Normandy at Hastings on October 14. All further battles up to the nineteenth century were fought abroad by small armies (e.g. a signboard at the Crispin Inn at Ashover records the return of Thomas Babington of Dethick from Agincourt in France). A few were killed in the Civil War, but most events in Derbyshire were brief skirmishes (Wingfield Manor was captured and dismantled by the Roundheads). Only in the twentieth century were young men conscripted into mass armies and slaughtered wholesale (next chapter).

All earthquakes have been minor; volcanic activity ceased long ago except for hot springs; and there are no recognized impact craters in Derbyshire. The walls of the Dale River and Bilberry reservoirs collapsed in 1864 and 1852 with 244 and 81 dead. Landslides are common on the shales.

All in all, it appears that diseases aggravated by unhygienic living conditions and bad food (especially for the poor) were the major problems in Derbyshire until the present century. It is easy to be discouraged by the problems that face us now, but life in the Middle Ages was short and brutish for most people.

Derbyshire was out of the mainstream of intellectual life and there are only a few literary works. Thomas Hobbes, a pioneer in utilitarian philosophy and author of *Leviathan*, was born in 1588 and lived to ninety-one. He was tutor to the Cavendish family in the old Chatsworth House and Hardwick Hall from 1608 to 1679, and was fascinated by the geology of the Devil's Arse at Castleton (two round hills for buttocks and the Peak Cavern for the anus). The idyllic pastoral life was immortalized by Izaak Walton whose Fishing House in Beresford Dale is described in *The Compleat Angler* (1653). Daniel Defoe (1660-1731), author of *Tour Through the Whole Island of Great Britain*, described the silk mill at Derby, the Barmoot Court for lead mines at Wirksworth, an uncouth lead miner and his cave-dwelling family at Brassington, mineral baths at Buxton, and a wasted relic of Sherwood Forest. Jane Austen's heroine, Elizabeth Bennet, of *Pride and Prejudice* (1813) stayed at the Rutland Arms Hotel in Lambton (Bakewell) and was surprised by Mr. Darcy at Pemberley (Chatsworth); the lower classes are nowhere to be seen! Charlotte Brönte's *Jane Eyre* (1847) is set in the Hathersage moors - an Eyre of Highlow went to Agincourt. True to form, George Eliot revealed the deep psychological tensions in the life of *Adam Bede* (1859), who is based on her father Robert Evans. The portrait of Dinah Morris, the hypnotic Methodist preacher, is based on Elizabeth Evans who moved to Wirksworth (alias Snowfield) from Nottingham; her husband managed the tape mill that still survives.

Joseph Wright of Derby (1734-1797) pioneered the painting of industrial and scientific subjects. *An Experiment with a Bird in the Air Pump* (Tate Gallery, London), *A Philosopher giving a Lecture on the Orrery* (Derby Art Gallery), *Sir Richard Arkwright*, *Jedediah Strutt*, and *Arkwright's Cotton Mills by Night* (private owners) demonstrate the psychological fascination with the new sciences and technological applications.

Miss Florence Nightingale, who revolutionized nursing, lived part of her life at Lea Hurst next to Holloway, and must have seen the medical problems of Derbyshire. However, most of her work was elsewhere (London, Germany, Italy, Crimea), or conducted from her bed in later life.

These creations of the past humanize the dry records of Derbyshire life, but provide only tantalizing glimpses of the complex social life which must have underpinned the ecological developments. It is the first two chapters, which deal with the life of my family in the twentieth century, that show detailed knowledge of the rapid changes that were revolutionizing the human condition in Derbyshire.

Chapter 4

Cambridge, The Scientific Shangri-La

1945-1951

It is a truth universally acknowledged that Cambridge scientists had, and still have, a lot of reasons to feel superior, and that they can get away with just being quietly so! They enjoyed advantages given to few other scientists in the world, and I was now entering their Shangri-La.

Like the other undergraduates, I lived in college except for a year spent in a Dickensian lodging house on Green Street. Gonville and Caius (pronounced ‘keys’) College was established by the Bishop of Norwich, William Bateman, using a bequest from Edmund Gonville made in 1348. A further endowment in 1557 by Dr. John Caius, a graduate of the medical school of Padua and physician to Edward VI and Mary I, doubled the size of the college. Then the students entered through the Gate of Humility, now in the Master's garden, passed through the Gate of Virtue, and went out of the Gate of Honour to obtain degrees at the Old Schools. Caius was reputed to be a very rich college with large rents from East Anglian farms, but the accounts were known only to the Master and Fellows.

Following in the tradition of John Caius and William Harvey, the Caius student who discovered the circulation of the blood, many of the undergraduates studied medicine. They tended to go in for rugby football, gallows humor, and booze, partly in response to the strain of systematic dissection of cadavers. The college was also popular with Welsh students. From Sam Edwards, I learnt about the harsh conditions of the workers in the anthracite coal mines, and began to understand the psychological drives behind

Aneurin Bevan, the abrasive Socialist Minister of Health, and Dylan Thomas, the self-destructive poet. However, very few of the students had detailed knowledge of working-class life, and most came from the upper and professional classes. College life was an automatic extension of life at public or ancient grammar schools, and most freshmen slipped into the social networks of the upper classmen and dons. The outsiders like me began to learn the ropes but missed most of the social life of the wealthy students.



Joe as a student on the "Backs" of the River Cam in Cambridge.

Food was shorter in 1945-8 than during the war as Europe underwent reconstruction and USA food was diverted. One pat of butter a week and a packet of sugar was our ration. Vienna steak, overcooked vegetables, and boiled suet pudding with custard was a typical dinner. Cold fish, cheese and biscuits was the invariable Sunday dinner to give the cooks and waiters the night off. Eggs sent by my mother were very popular. Our rooms were unheated except for a rare coal fire, for which a hundred-weight bag was allowed each term. It seems spartan now, but most of us thrived on it. The only drugs were tea, coffee, alcohol and tobacco. Most of us could afford beer only once or twice a week, and got drunk only a few times during college feasts and bump suppers. I got hooked on cigarettes and a pipe that I chuffed in what I thought was the proper intellectual manner. It was a luxurious life for a farm boy; all expenses paid, a bedder to do the chores, and waiters in hall!

Three lectures six mornings a week, three-hour labs on Monday-to-Friday afternoons, several

tutorials in early evening, and problem sets, took care of most of the day and some of the night. I rowed in the college eights, all of which lost places in the bumping races, in contrast to the high success of recent eights from Caius. Many nights we discussed the meaning of life until dawn without achieving any grand conclusions. I particularly remember the extracurricular lectures of Bertrand Russell who filled several of the Mill Lane lecture rooms connected by audio. The political societies peddled their wares, and the best-attended meetings were run by the United Nations Association. Just like the students of the twenties and thirties, who watched the growing impotence of the League of Nations, we saw the hopes of the United Nations wither away as the Cold War developed between the Communist and Western Democratic alliances.

We were a sober but happy group of students. The young chickens fresh out of high school picked up the steadiness of the veterans of World War II. Upon becoming a research student in 1948, I began to supervise undergraduates. An ex-lieutenant-colonel accepted my chastisements about his intellectual work with good humor, and taught me how to fold an elegant bow tie. I learnt directly about the battles of World War II, and about how easy it was to become dead. Slowly the general principles of atomic (nuclear) bombs, radar, etc. became known to us, though many specific technical details remained secret.

Standing out were the ex-GIs who lived in the Bull Hostel on King's Parade. One Saturday afternoon at the football ground in Grange Road, the Yanks challenged the University rugby team, one-half British style and one-half American. An American giant, looking like a Chicago Bear, spread out his arms and mowed his way through the fast but outweighed Cambridge team. Doughnuts, coffee and coke were served. We loved the swing and jazz music from the American Forces Network - much more vibrant than the standard fare on the BBC. U.S. movies dominated the cinemas. Jane Russell was a hit as she smouldered in the hay; "The Outlaw" was dubbed "Lust in the Dust." Charlie Chaplin and the Marx Brothers were critically acclaimed in the student reviews.

The scientific tradition at Cambridge goes back to the discoveries in mechanics and optics by Isaac Newton, the second Lucasian professor of mathematics (1663-1701). Retirement to Lincolnshire during the Great Plague (1665-1667) produced the great discoveries. (Most university scientists would give their eyeteeth for two years away from the day-to-day grind of present duties, but the chance of matching Newton is now zero!). With help from the chancellor, William Cavendish, duke of Devonshire, the Cavendish laboratory was built, and James Clerk Maxwell, the father of the electromagnetic theory of light, became the first professor of experimental physics in 1871. Sir Joseph J. Thomson discovered the electron in 1897, and developed the mass spectrograph that led to the discovery of isotopes.

Having just read Eve's biography in 1945, I was particularly impressed by the life of Ernest Rutherford, a farm boy from New Zealand, whose experimental discoveries at Cambridge, McGill University, Manchester University, and finally at Cambridge as Cavendish Professor (1919-1937) laid the

groundwork for so much atomic and nuclear physics. Rutherford proved that nitrogen nuclei had been split by alpha particles (1917-1919), and his prediction of the neutron was confirmed by James Chadwick in 1932. The role of honor marches on to the present day as Cavendish physicists revolutionized many disciplines including astronomy, molecular biology and materials sciences. No wonder I was in seventh heaven as I walked down Free School Lane to take classes in the Cavendish Laboratory in October 1945.

In later years, I realized that the Cavendish Laboratory was a jumble of undistinguished grimy buildings fitted higgeldy-piggeldy into a crowded site as new laboratories were needed. The glory days of simple apparatus made from bits of old metal and glass were going as teams of scientists and technicians built complex instruments. Administrators ran sub-departments, as physics pyramided outwards into many specialties. The only touch of style was Peter Kapitza's crocodile cut into the wall of the Mond Laboratory by Eric Gill. This reptile had double symbolism for the Russian Kapitza. His father figure of Rutherford personified the irresistible drive of physics research forever thrusting into the future. Furthermore, new knowledge might lie quietly in the mud until the jaws snapped as an application was discovered. The elegant concepts of natural philosophy were now being coupled with the mechanical know-how of the Industrial Revolution, and the Cavendish scientists had lost their innocence like everyone else. Nevertheless there was, and still is, an air of superiority over those scientists who labored in the non-academic worlds.

When I arrived in Cambridge, Rutherford had been dead for eight years, and Sir William L. Bragg quietly presided over advances into new areas of science. His Australian father, W.H. Bragg, did no original research until 1904 when he was 41 years old. Then he correctly described the absorption of alpha-particles, and was elected to the Royal Society in 1907. The son graduated from Adelaide University, Australia, in 1908, and entered Trinity College, Cambridge, in 1909 after his father became Professor of Physics at Leeds. Then, the duality between the particle and wave nature of matter and radiation had not been established. In 1912, the two Braggs clearly demonstrated the wave aspect of X-rays from the geometrical properties of diffraction from simple materials, and went on to establish how atoms are packed together in a range of crystal structures. WLB learnt about the joint award of a Nobel Prize in 1915 as he was setting up the first sound-ranging station at Ypres.

In 1945, X-ray crystallography and electron microscopy were becoming just two of the important tools in the Cavendish Laboratory as the physicists spread out into almost all areas of science including biology, metallurgy, earth sciences and astronomy. The Heroic Age of Rutherford was developing in other universities and government laboratories into the Megalopolitan Age of the Particle Physicist. Fortunately the quiet ideas of WLB turned out to be just right for the Cavendish as it retained its skill in picking out important new areas of science that could be tackled with modest resources. All the research teams were small, and it was still possible to work on one's own without getting lost in the crowd.

The scientific teaching at Cambridge had become superb in the twentieth century after a slow start in the nineteenth century. A rigorous integrated set of courses on physics, chemistry and mathematics constituted the heart of the Natural Sciences Tripos. I took the optional course in mineralogy and crystallography, and specialized in physics for Part II. By concentrating exclusively on science, we reached the equivalent of a U.S. Master's degree in three years.

Almost without exception, all the lectures that I attended were given by brilliant scientists working at the forefront of knowledge. David Shoenberg, my Director of Natural Sciences at Caius College, was extending the discoveries of Kapitsa in low-temperature physics. J.A. Ratcliffe's lectures on electricity drew on his wartime experiences, and we made measurements on wave guides and magnetrons developed for military radar. Smoothest of all was William H. Taylor, a brilliant crystallographer from Lancashire, whose lectures on the atomic structure of crystals cannot be described with any better adjective than crystal-clear! Herman Bondi's thick Hungarian accent was completely incomprehensible, even to a farm boy used to heavy rural dialects, but his mathematical equations were clear enough. Bertha Jeffreys was the only woman in this male world, and her quiet voice helped us through the mysteries of complex functions. The only failure was E.C. Bullard, who missed three out of six lectures, and was not even prepared for those three. Doubtless we were small potatoes compared with his new discoveries about the ocean floor.

Least popular with me were the experiments in the old chemistry laboratory. The air was foul with chemicals and the experiments were tedious. Looking back I am appalled at the lack of safety precautions; poor flow of air, no safety glasses, little or no warning about toxicity. We smelled all the chemicals as a matter of routine, and I finished the final one-hour exam on identification of an organic chemical in a few minutes after checking a guess made from the smell. Even modern chemical laboratories are pervaded by filthy smells, and I expect that some students are still as slaphappy as I was.

The hazards in the physics laboratories were less obvious. Every physicist knows how the dangers of radioactivity were first demonstrated by the sicknesses of Marie and Pierre Curie. Nevertheless, some laboratories became contaminated as late as the forties. Shielding of X-ray generators and cameras was still primitive when I started research. One student claimed that he deliberately irradiated his testicles so that his girlfriend would not become pregnant. Doctors and dentists took more X-ray micrographs than today, and lead aprons were not used. Chests and wombs were irradiated with strong beams. Feet were X-rayed to check the fitting of shoes as late as 1960. Of course, the careful use of X-rays is medically valuable, but even in 1985 some dentists seemed over keen to take a full set of plates.

Fortunately, safety precautions were growing in the forties. All research students in crystallography wore radiation badges. Each term our blood was checked at Addenbrooke's Hospital. We dreaded the ordeal, as the nurses were learners and the hypodermic needles were old and blunt - some nurses needed several tries to find a vein and we ended up with bruised arms. A tall student, Peter Robinson, stood up after the blood-taking and pitched forward onto his face, breaking several teeth. After that, we were told to sit still until the blood pressure had equalized around the body. One student lost 80% of the white corpuscles, and was put in a convalescent hospital for several months.

Returning to the farm for vacations was schizophrenic. It was delightful to get back to the birds and the bees, but the intellectual excitement of Cambridge was irresistible. All over the world, the farm boys were drifting to the cities; only a few had my good luck to be at an intellectual Shangri-La.

Farming was changing rapidly in Derbyshire. My father bought a tractor, and within ten years the three horses had gone. The quiet walking down the furrow as the horses pulled the plough intelligently was replaced by the incessant beat of the engine next to the seat. Sweet aromas, punctuated by the occasional pungent fart from a horse fed on beans, oats and hay, were replaced by the sour plume from the exhaust. I ploughed twice as fast, but I was numbed and slightly poisoned by the end of the day. Milk production increased as cows replaced the horses; indirectly, petroleum was being turned into food. Crops increased as more fertilizer was used. It was more difficult to find mushrooms in the fields, and we speculated that the fertilizer killed the spores. There were fewer birds and butterflies.

Back in Cambridge, I received a B.A. (Hons.) degree in 1948. Imbued with the intellectual ethic of a Cambridge scientist, I hoped to become a research student, and indeed the appointment came through. Before then, I interviewed with industrial companies and military establishments. Cadbury's in York offered me a job to develop techniques to measure the particle size of chocolate. I was fascinated by the three-dimensional radar being developed at the Malvern radar establishment. This type of radar, plus the subsequent weather radar, became one of the keys to the successful expansion of civil aviation.

What type of research should I do? Nuclear physics had glamour, but it was already the era of the big machines operated by large squads of scientists and engineers. Anyway, Cambridge had fallen behind as its van der Graaff accelerator and cyclotron were outclassed by the synchrotrons & bevatrons in the USA. The teaching of crystallography and mineralogy by R.C. Evans, N.F.M. Henry, J.F. Nye, F.C. Phillips and W.A. Wooster had been superb, and the book *Chemical Crystallography* by C.W. Bunn had kept me up all night. So I joined W.H. Taylor's group, and ultimately came under the supervision of a brilliant scientist, Helen D. Megaw, whose achievements were recognized only late in life. William Cochran taught me the rudiments of theory and experiment, and I admired his skillful work on experimental techniques and theoretical interpretation of chemical bonding and lattice dynamics. Peter Hirsch determined the ways in which complex materials like coals and metal aggregates were assembled.

I wanted to work on the atomic structures of feldspar minerals, which are present in most rocks at the Earth's surface, but four students from Wisconsin, Canada, Australia and Norway had already been assigned to this research area by WHT. So I was given the job of determining the orientation of single crystals of solid mercury for the scientists in the Mond Laboratory. This was excellent training in building apparatus and making measurements, and I was essentially told to get on with it from then on.

Stuart Agrell, a petrologist from the Department of Mineralogy and Petrology, gave me specimens of spurrite, scawtite and tilleyite, which are three rare minerals formed by the reaction of limestone with basalt. It was important to find out how the carbonate component interacted with the calcium silicate component in order to interpret how these minerals grew at different temperatures. All three have complex

crystal structures that proved difficult to solve with the primitive techniques of 1950.

After two years of struggling with thousands of spots on X-ray films, and many hours of tedious calculation for each test, I became discouraged. Nowadays with the latest automatic diffractometers and computers, I would have knocked off all three in a month. Finally in the third year, I solved the structure of tilleyite and duly collected my PhD passport to a scientific career.

Looking back, I can see the advantages of this training in crystallography. It was a well-defined subject with simple apparatus, and I was able to do everything myself. I had time to read all the books and understand the entire theory. There was no need to worry about money because all research costs and my stipend were guaranteed for three years. My colleagues were applying crystallography to a wide range of subjects including biochemistry where M.F. Perutz, J.C. Kendrew, F.C. Crick and J. D. Watson were hitting the headlines. It was a Golden Age in crystallography, and it was hard to leave Cambridge. But here again, fortune favored me.

The Geophysical Laboratory of the Carnegie Institution of Washington was the mecca of scientists interested in the chemistry of rocks. W.H. Taylor recommended me for a fellowship, and I rushed home to get married to Brenda Wallis, a beautiful and intelligent girl from Fritchley, Derbyshire. We had been at Fritchley elementary school, where she later told me that she had picked me out for a husband at the age of ten! She had gone to Ernest Bailey school at Matlock, and become a librarian, and was not allowed to go to university as would be the usual move now. I spotted her behind the counter of Belper Library, and the rest was easy, when I found out who she was. A Fulbright travel grant paid our way across the Atlantic, and we pair of wide-eyed innocents landed in New York on the Queen Mary in September 1951.



Chapter 5

Farmer's Boy Goes West Twice

1951-1954 and 1956-2007

It is still exciting to cross the Atlantic Ocean, even in these days of egg-crate mass delivery by a 767, Airbus, or some other efficient but mechanical magic carpet. But in 1951, it was a dream come true to embark on the liner Queen Mary. My wife had spent many happy holidays with her family at the seaside, especially in south-west Scotland. However, I had worked on the farm during holidays, and did not get to sea until September 1949. During breakfast at Caius College, I realized that I had become an adult without reaching the coast. So I hopped on my bicycle and rode in brilliant sunshine to King's Lynn where the North Coast cuts into East Anglia. The mud flats and the calm sea were boring and depressing, but the old houses were interesting. So back to college through the fens with some egg plums for refreshment, and standing at a performance of Shakespeare's *Midsummer's Night Dream* at the Arts Theatre to finish off a remarkable day. Two years later, Brenda and I left Ambergate railway station in Derbyshire for the port of Southampton.

It is amusing now to look back at the fragmentary information that we then had about the USA.

The Hollywood movies were great entertainment, but the purple passions and garish glitz could not truly represent all the American past and present. Nevertheless, a genuine feeling of vitality, excitement and can-do philosophy shone out from the better movies such as *Gone With the Wind*, *Bringing Up Baby*, *Casablanca*, *Duck Soup*, *Destry Rides Again*, *Double Indemnity*, and, of course, *Mr. Smith Goes to Washington*! During World War II, the GI's were both envied and disliked for being oversexed, overpaid and over here, but I had a great time in London with the jovial sergeants at the wedding of one of them to my cousin Doreen. More seriously, I was excited by the many scientific and technical advances in the USA, had listened regularly to Alistair Cooke's Letter from America, and had studied Dennis Brogan's books on the political structure. In 2005, I read Richard Parker's biography of John Kenneth Galbraith, a farm boy from south Ontario who became a popular economist and government planner in the USA, and can relate to his early struggles, but not to his neglect of geophysical dangers in his recommendations to Presidents of the USA.

Brenda and I could not get a passage in Tourist class, and were forced to travel above our means in Cabin Class, one notch below First Class. While we lived in luxury, the pale-faced stewards took turns in sleeping on damp metal bunks screwed to the hull below the water-line. Food was still in short supply in Britain, but we were fed from dawn to bedtime. The bread was white instead of the grey color of British loaves - actually, the latter were more nutritious because they contained more gluten. Every type of meat, fish and fruit was on the menu. My lack of finesse at dancing was not so obvious as the deck bounced and tilted. It was generally cold on deck because of the 30 mile per hour wind and cloudy skies, but one magical night was lit up by the moon and stars. The klaxon drove us crazy on the fifth day as we passed through the inevitable fog belt where the cold Labrador current reaches the warm Gulf Stream. On the seventh morning, we entered the Hudson River, sailed past the Statue of Liberty, passed the immigrant sheds on Ellis Island, and tied up on Pier 90 at the middle West Side. Quite a difference from the voyages of the "huddled masses yearning to breathe free." Nevertheless the thrill was there as the Chrysler and Empire State Buildings signaled the golden door of Manhattan Island.

The taxi driver pointed out the key buildings as we went to Grand Central Station. At first we could not find the underground trains! The ride in the evening to Washington DC was truly overwhelming. Huge car parks, full of large vehicles, lit up by bright lights; large buildings; and corn fields. Everything was on a bigger scale than in England; plus lots of open space filled with scrub trees. At Union Station, Frank Tuttle picked us up, and we stayed at his home in a Maryland suburb. His wife Dawn served a wonderful breakfast, and Frank drove me to the Geophysical Laboratory. This was a classical building on a rock outcrop off Upton Avenue with a view over Rock Creek Park. I got an advance of a month's salary and Brenda and I started to hunt for an apartment in an almost impossible market. By luck, we found one at 1615 Kenyon St about a mile across Rock Creek from the Geophysical Laboratory.

Over the next 3 years, we traveled over much of the continental USA, and read a lot of American



The Geophysical Laboratory of the Carnegie Institute, Washington, D.C.

history that gave a different emotional flavor to that taught in British schools. At weekends we went to Jamestown, Virginia, and various sites of the Revolutionary War; the Blue Ridge of the Appalachian Trail (including a Christmas day, when we picnicked on Stonyman, and did a sine curve on a two-lane highway to avoid a drunk driver bouncing from side to side on a near cosine curve); Harper's Ferry (still in ruins), Gettysburg (President Eisenhower was celebrating an anniversary), Antietam, Bull Run, and many other classic sites of the Civil War (= War between the States); Colonial Williamsburg; West Virginia (where farmers were using the technology of the thirties in Britain- so "Everything is up to date in Kansas City" but not in West Virginia).

Our most important trip was in summer 1953 when we drove out to Idaho, not quite having enough time or money to make the Pacific coast. Wow, what an eye-opener. The Pennsylvania Turnpike was the only piece of advanced road, cutting through successive ridges of the Appalachian Mountains, now but not then known to result from collision with North Africa as the continents drifted. Ohio and Indiana were remarkable for the large farms and the lakesides. Gary was a smoky mess, Chicago was a huge mish-mash of small ethnic villages surrounding a growing downtown with a great Art Institute and Lincoln Park.

Crossing the sand dunes and glacial moraines, we ultimately made it to Madison WI, where our hosts Bill and Marilyn Bailey made us fall in love with a great state university. Bill was known as the "razor king" back in Cambridge because of his skill in cutting crystals into the right size and shape (near-spherical cube, 0.2 mm across) for crystal structure analysis. The views from the Student Union and



Joe and his first car. On his and Brenda's first Christmas in the U.S., they only had enough money to buy themselves one bottle of wine. As they opened the car door, it rolled out and smashed on the street. No Christmas present for them that year!

Observatory Hill (with its Indian mounds) were so calm. As we drove north we saw herds of cows in the fields, Dutch-style barns, corn just reaching knee-high. My father would have loved it. Further north we reached Duluth with its Skyline Drive and saw the ore boats taking iron oxides down to Gary IN. We camped at Lake Itasca, the source of the Mississippi River, where we ran for our lives being pursued by a growing swarm of mosquitoes.

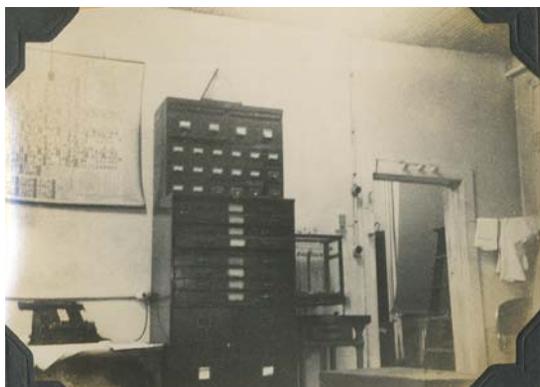
Then into Canada: here the main road to Winnipeg suddenly turned into a washboard corrugation that almost made the car jump off the road. After driving for some hours followed by a dust cloud we reached the home of Bob Ferguson, another crystallographer from Cambridge. I caused great surprise when I remarked how cold it was: it was actually the hottest day so far in a wimpy Winnipeg summer!

Back to the USA and through the Dakotas into Montana, Wyoming and Idaho. We hiked in the badlands; saw the graves of Wild Bill Hickock & Calamity Jane in Boothill Cemetery; were stunned by the glacial and volcanic scenery of Glacier National Park and Yellowstone, counted the 57 seconds for Old Faithful Geyser (less regular when we revisited in 1965), saw the wonderful colors of the hot springs; photographed Jupiter Terrace (destroyed later by an earthquake); looked at dinosaur remains; studied Indian culture and stumbled over the Medicine Wheel which reminded us of Arbor Low in Derbyshire. It was clear that farming was a major challenge with many areas being abandoned. We would sometimes drive for 50 to 100 miles without meeting another car. Of course, there were no longer the uncertainties

faced by the early mountain men and trail people, but it was necessary to carry extra gasoline and food.

Turning back east, we found shacks one block away from the impressive State Capitol in Denver CO; nice parks in all Kansas towns; many different types of flowers, animals and birds, including a road-runner. We lost the clutch in West Virginia, and I just managed to nurse the car back to DC.

As a Fellow of the Carnegie Institution of Washington, I was totally free to pursue my own interests. There was no money to buy X-ray generators, and I built mine. I found an old transformer and a tube head; made a water safety switch from a cocoa tin with a hole in the bottom attached to a spring that activated mercury in a bent glass tube. Chicken wire completed the safety control, and I kept the door locked. Total cost was about two dollars plus several days of my time. I was able to get 4 single-crystal diffraction photos a day from 2 X-ray cameras, set up at 8 AM and 8 PM.



Inside the Laboratory



The "Doghouse" at the Geophysical Lab

William Scott MacKenzie came as a Fellow in 1952, and became a life-long friend. His experience was originally with Scottish geology. He learnt the techniques of growing synthetic minerals and rocks from the GL staff, and took them to Manchester University where he built up a great school. Mac and I began to sort out the phase equilibria of feldspars combining my knowledge of solid-state chemistry and physics with his knowledge of rocks.

One day, I deliberately set out to learn geology, and read Arthur Holmes's text "Principles of Geology". At that time, continental drift was scoffed at because everyone knew that the Earth's mantle was too solid; that Wegener was a foolish visionary; and the fit between eastern North America and western Africa was merely an accident. Not until the late 1960's did plate tectonics come into vogue, as was consistent with the physics of Keith Runcorn's sedimentary mineral magnets. Proponents of impact for circular craters were also regarded as loonies until experimental mineralogists made the coesite and stishovite polymorphs of quartz, and these high-pressure varieties were actually found in meteor craters. These are just illustrations of the staggering advances in the geosciences in my lifetime, and make possible the present understanding of how mankind fits into the physical world.

After three eye-opening years in the USA, Brenda and I returned to Cambridge in 1954 where I was appointed Demonstrator in Mineralogy and Petrology (=Assistant Professor) at the lowest level with no credit for 3 years at the GL. Here, I was able to continue research on feldspars. With Stuart Agrell and Henry Emeleus, I collected feldspar-bearing rocks from a series of volcanic and plutonic rocks in Ireland and Scotland. In 1956, Frank

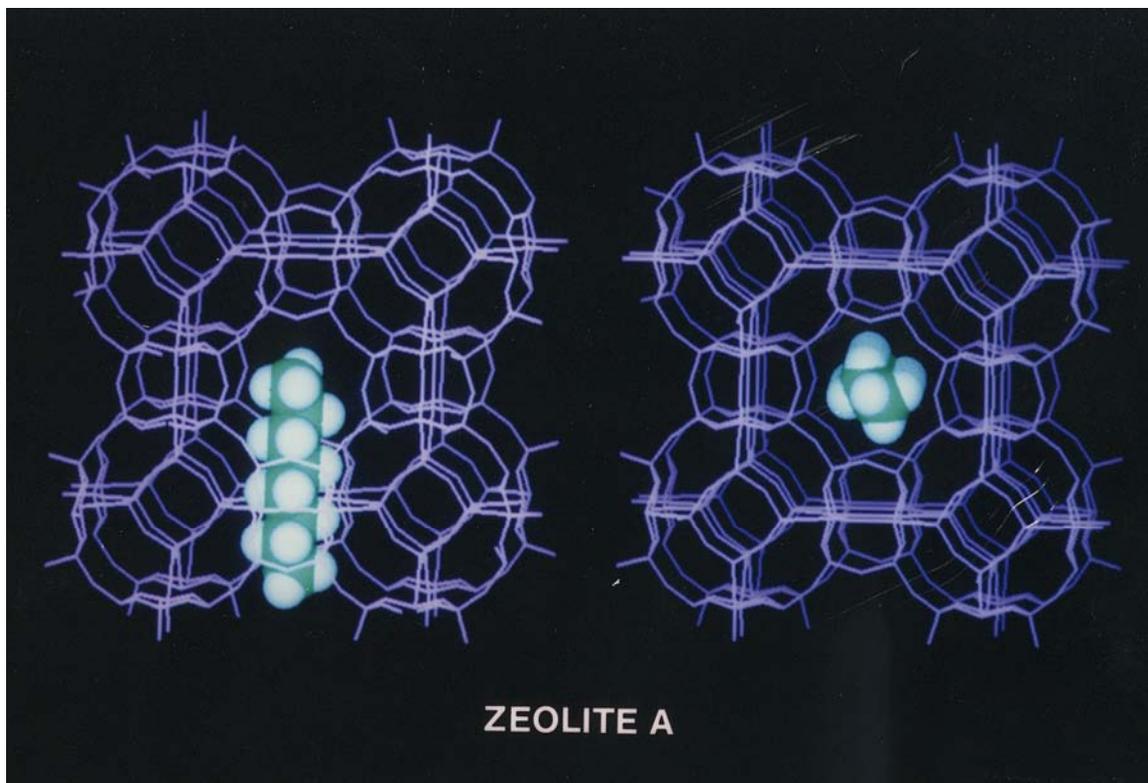


Ginnie, Joe's mother Edith, his sister Hilary, Susan, Brenda, and father Henry in Cambridge.

Tuttle invited me to join his Division of Earth Sciences at Pennsylvania State University. I did not want to leave England, but on checking around no suitable tenured position was available. Oxford paid strictly by age, and my advanced experience did not count; Bristol decided that I would be better off at Penn State; and Cambridge stated that no tenured positions would be expected for some years. So we left for State College PA in November on the Maasdam through storms so bad that even the crew were sea-sick. I remember sliding on the floor of the nursery as the ship pitched and rolled. One morning only six passengers made breakfast. I just survived by drinking bubbly ginger ale, but had a severe pain across my stomach from the tension. We arrived in Hoboken one day late. I bought an old Plymouth automobile; took out the back seat, and fastened it to the roof; and loaded five cabin trunks, two boxes of X-ray cameras, and miscellaneous children's bags. We slowly drove across New Jersey and ultimately reached State College, Pennsylvania, the next morning.

Four years at Penn State were wonderful. It had become the leading department of experimental geochemistry in the World under Elburt Osborne and Frank Tuttle, with Peter Wyllie and other experimental geochemists starting to map out the melting of magmas from the mantle. At national scientific meetings, the "white-coat" brigade were notorious for their new ideas on the application of solid- and liquid-state theory and practice to a wide range of matters from ceramic technology to geology. George Brindley, Head of Ceramic Technology, advised me not to become an administrator, as he had done, and stick to scientific research like he had done in Leeds before crossing the Atlantic. There were bitter fights between the heads of individual departments that I was almost able to stay clear of.

To pay fares back to England, I became a consultant to the Linde Division of Union Carbide Corporation at Tonawanda NY where I worked with Don Breck and associates on synthetic zeolites



The structure of zeolites, on which Joe did a great deal of work.

Although I originally consulted for the money, the science turned out to be world-shattering. Originally it was hoped that the new synthetic zeolites would prove cost-effective in separating oxygen from nitrogen in air. Indeed, in remote areas, the zeolite pressure-swing process does work well for waste-management systems where the oxygen speeds up bacterial activity. It is also used for providing portable oxygen for people with defective lungs, as for my friend Scott MacKenzie. However, most oxygen for medical purposes and for steel mills is still made by cooling and fractional evaporation. Linde Type A zeolite came into commercial success in washing powder when it replaced phosphorus compounds that led to noxious algal blooms. Rivers and lakes, especially Lake Erie, regained their clarity. Linde Types X and Y were found to be low and high Si/Al analogs of a very rare mineral called faujasite. In the early 1960's, variants of Linde Y were found by Mobil scientists to triple the yield of gasoline from petroleum when they replaced the old amorphous catalysts. Together with the 3-fold increase of petroleum from an oil field as a result of advances in 3D seismic imaging and drilling techniques, the approximately 10-fold increase in gasoline supply has made it possible for us all to have access to automobiles in the developed Western world. My role was to answer basic questions concerning how many zeolite frameworks were possible (no theoretical limit mathematically); how were structural frameworks of the existing zeolites assembled from sub-units, and could the pieces be assembled in other ways (this took me back to polyhedra from Greek mathematicians, and nets from Kepler); was there a limit to the size of windows for the molecular sieves (not mathematically, but only from energy considerations); how many atoms could be expected to go into the zeolite frameworks; where did the exchangeable cations reside in the crystal structures; and so on. This involved me becoming competent in a wide range of experimental techniques, including neutron diffraction

and solid-state nuclear magnetic resonance and infrared spectroscopies.

In 1960, I moved to the new Department of Geophysical Sciences at the University of Chicago. It was a tough decision to leave the dynamic Penn State, but Frank Tuttle was leaving for Stanford with Dick Jahns (this provided a warmer climate for his newly diagnosed Parkinson's disease), and Julian Goldsmith was so keen to get me that I was appointed full Professor at the age of 32. Furthermore, the pension system at Penn State was tied to the state tax money, and did not allow for subsequent mobility like the TIAA-CREF system used at Chicago.

The University of Chicago was a tough place to be during the 1960's. The air was filthy with black dust from the soft sulfur-rich coal used for heating. The fear, but not the actual danger, of street crime was high, and the black people tended to be unfriendly to whitey, which was not surprising considering that they had come up from the Deep South. On the positive side was the sheer drive to teach and do research at the highest level. The administration was in a flux as the Hutchin's College was transformed into an unusual combination of a liberal arts college with graduate schools, and much of the teaching was done by research scientists and liberal artists. I taught a course on Symmetry Theory and its Applications – term papers ranged all the way from Symmetry in Music and Poetry to the Abuse of Symmetry in Architectural Design. In the graduate program I taught courses in mineralogy and crystallography, and took students on field trips to Devil's Lake, WI, and the Indiana Dunes. On the College Council, I met Bill McNeill the historian, James Redfield & Arthur Adkins the classicists, together with a wide range of social scientists, as well as physicists, chemists and biologists.

The Department of Geophysical Sciences was cobbled together from the old departments of Geology and Meteorology aiming to study all aspects of the Earth. Each Friday lunch, a faculty member described some feature that interested him. I remember Dave Atlas and Ted Fujita describing radar techniques at the most primitive level that have now become sophisticated key aspects of weather on TV. Airplane pilots can see turbulence ahead with Dave's radar. Ted showed downdrafts responsible for some aircraft crashes, and tornadoes, and became known as *Mr Tornado*. I described the work on zeolite molecular sieves, and was surprised that it was regarded as too applied by several faculty members. Indeed, a negative aspect of the Division of Physical Sciences was the feeling that that anything useful in life was not as important intellectually as something non-useful and purely cerebral. My experience has been that the industrial chemists have been ahead of the university chemists in catalysis, and that my own cerebral ideas have been triggered off by questions arising from money-making applications.

By the end of the 1960's, the missions to explore the planets were well under way, and the mineralogy of meteorites was making progress. All these matters came up at the department seminars and broadened our minds.



A family field trip to Arkansas.

At weekends, I would take my family, and occasionally students, on local field trips. The Midwest is popularly regarded as flat and boring, but it is actually fascinating when you learn what to look for. In the Chicago region is detailed evidence of climatic change. On the edge of Lake Michigan are sand dunes dating back several thousand years. Further out is a partial ring of glacial moraines going back some 20,000 years. Even over the last century and millenium, there is evidence of major changes in the weather and climate, with strong implications for the future climate. First, is the dune-swale complex near Gary that indicates cycles of 30 and 150 years covering northward retreat of Lake Michigan when hot-dry conditions

prevail, and southward advance for wet-cool ones. Second, the moraines testify to glaciers sweeping down from the north every few thousand years, in one case cutting off the outflow to the Atlantic Ocean, and forcing the water to go down the Mississippi Valley. This evidence is not known in detail to most carbon meteorologists, and has major implications for the future. It will take a century or so to tell whether these cycles will persist as humans put more greenhouse gases into the atmosphere: currently, the amount of dioxide in the atmosphere is higher than for a hundred thousand years because of recent human use of energy.

Moving north to Wisconsin, there is terrific evidence of glaciation, including Devil's Lake. The view from Gibraltar Rock is stunning. Going south, there are glacial moraines near West Lafayette, Indianapolis and Cincinnati that testify to very cold climates in the distant past. Indeed, if we were currently in such a cold period, we might well be hoping to melt off some of the ice by deliberate enhancement of the greenhouse effect. Going west to Montana, Wyoming, Washington and Idaho, there is spectacular evidence of huge floods that have left dry falls wider than Niagara and valleys filled with the debris from the past flows. In Iceland, such floods have been observed recently as a glacial lake in Iceland broke its own dam, and poured out. It is obvious that in the early twentieth century, we became fooled by the smallness of the climate variations, and that planning for future centuries should take account of potential rise or fall of sea level by some tens of feet.

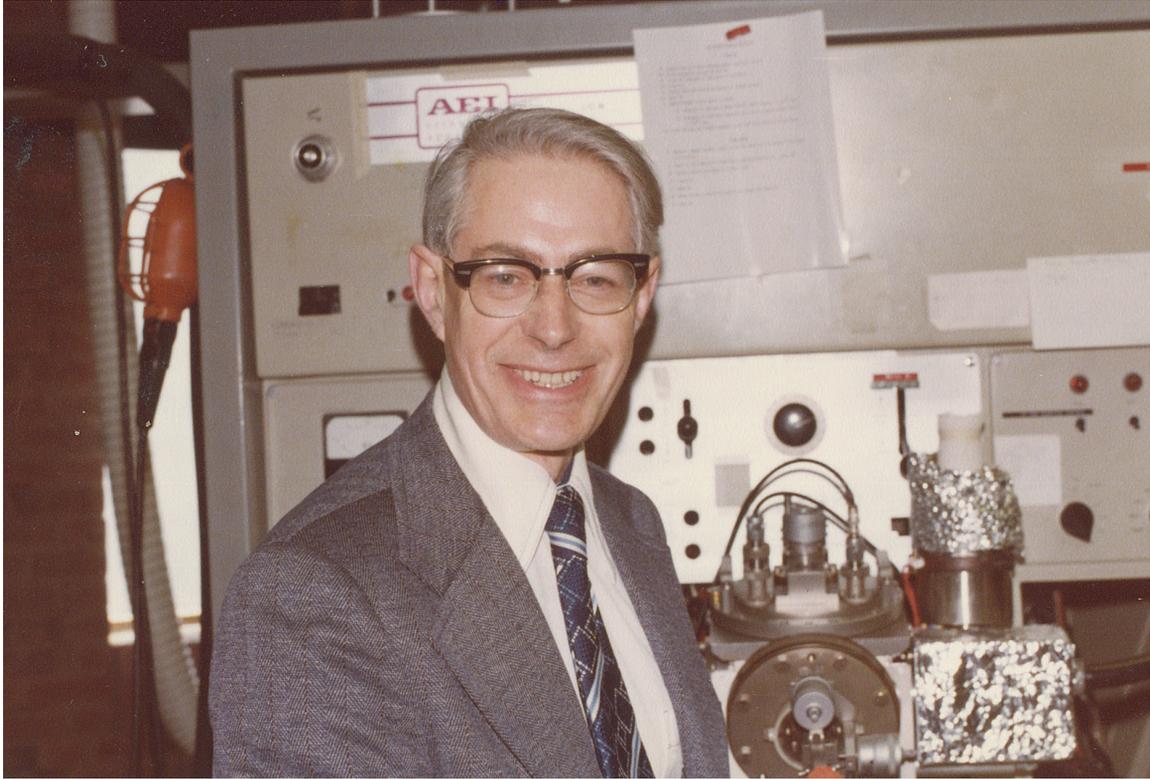
Chapter 6

Research Professor Reaches the Moon

1965-1975

The Apollo program to land men on the Moon was authorized by President John F. Kennedy to beat the Russians as part of the Cold War. NASA had established finally a successful rocket program that had led to photographic flybys. Frankly, I was surprised that the landings on the Moon went so well, with only the failure of the Apollo 13 mission from the 11 to 17 series.

In 1968, I concluded that it was impossible to form a cold Moon simply because there was too much kinetic energy in the accumulation process. This went against the opinion of Harold Urey, the guru who knew his chemistry but not the basic physics. Harold wanted the black areas on the Moon to be sediments from old lake beds. The Apollo landings confirmed that they are lava flows filling ancient impact craters. The current opinion of the gurus is that the Moon consists of the assembled relics of a glancing hit on the Earth by a Mars size planetesimal. Perhaps this is largely true, but there must have been many other impacts. Indeed the Moon may have grown in stages near the Roche stability limit from several bodies. What is particularly interesting is that the whiter parts of the Moon, which include the non-lava areas on the visible side and the unseen back side of the Moon are probably composed of white crystals of Ca-rich feldspar that floated on a magma ocean, thus explaining my question as a boy in Derbyshire. My proposal that the Moon has a small metal-rich core resulting from melting was regarded as wrong in 1969, but now seems more plausible. In 1969, the moment of inertia was thought to indicate that the Moon was denser on the outside than the inside, but modern measurements favor a heavy center.



Joe at the lab at the University of Chicago.



NASA administrators lost interest in the Moon and the later planned missions were cancelled in favor of the Space Station. Ultimately, NASA ran into trouble as it lost its best engineers, and political considerations drove unwise launches to a space station that led to costly failures with loss of life. In 2006, it is not clear what will be the future balance of space missions by NASA, but unmanned missions to comets and asteroids are opening up new thoughts. Perhaps major increases in funding will permit establishment of living quarters on a sheltered spot of the Moon, hopefully with ice and water available locally.

The implications for the Earth were truly fantastic for geologists. Dating of the earliest impact craters on the Moon gave values just under 4 billion years, some 0.6 billion years after the meteorites were believed to have been formed in the solar system. Because the Earth's gravitation pulls in bodies more than the Moon, whatever crust was on the Earth must have been smashed up by a denser array of craters than on the Moon. Indeed, the oldest rocks on Earth seem to be of similar age as the seas on the Moon, and perhaps a little younger. Metamorphosed sediments in Western Australia contain zircon crystals that date back to 4.3 billion years, and carry a trace element signature that indicates a granitic crust. Thus one can imagine that the Earth had a crust that was repeatedly smashed up with only the toughest minerals like zircon surviving in sediments. The mantle was boiling like porridge. Ultimately, the Earth cooled down and impacts weakened until proto-continentals survived the magma eruptions and impact metamorphism. These first continents probably had the low-melting components sweated out of them, leaving granulite terrains richer in carbonate than water. Ultimately most of the proto-continentals were broken up, and only a few pieces survive in western Greenland, Western Australia, etc. As the Earth cooled down, the type of convection changed erratically from boiling porridge (polygonal tectonics) to the current plate tectonics in which ocean ridges spread outwards as the various plates bend and twist in response to various forces.

The USA NASA agency opened up the sample study to anyone around the World with enough documented skills to provide a useful report. As such, my friends from Britain, especially Stuart Agrell, made major contributions to the theory of the Moon's origin and development. After the Apollo 11 mission with its sample return, the first Lunar and Planetary Science Conference was held at the Lunar & Planetary Institute near Galveston TX in March 1970.

This was a publication hoopla with TV and press coverage around the World. I presented a model for a hot Moon, with melting and floating and settling of feldspar crystals in a magma ocean, an idea that was also brought out by John Wood. I reported the first new mineral on the Moon, *pyroxferroite*, an iron-rich analogue of the manganese silicate pyroxmangite on Earth. More important, all the silicate minerals on the Moon were rich in calcium and iron, a tip off to the high temperature of its formation. From this evidence, I concluded that the Moon had formed erratically near the Roche stability limit from debris produced during accretion of the Earth. More and more it became apparent that large craters would also

have occurred on Earth, and that it was imperative to make further missions to the younger parts of the moon. [The Roche limit is the distance from which a body can hold together. Closer in, it fragments; further out, it slowly drifts away as tidal energy is consumed. Whereas the Earth has an escape velocity of 11 km/sec allowing loss only of hydrogen, the Moon has an escape velocity of 2 Km/sec allowing loss of heavier species.]

[Moved from an earlier chapter]

In 1965, my family and I went to CalTech for the spring quarter, where I was propositioned to join the faculty. I had to refuse immediately simply because the air was so bad that I was unable to look down a microscope in the afternoon, because of tears in my eyes. Although, the Chicago air was bad, it did not have as much of the photo-chemical reaction products that produced the milky acidity of the air in the Los Angeles basin. In spite of the bad air, it was wonderful to see the mountains and the Pacific coast, and to contrast the geomorphology of recent geology with that of the ancient rocks of the mid-West. Trips to the Grand Canyon, Death Valley and Joshua Tree were particularly instructive.

I learnt about the complex geology of the San Andreas earthquake zone, and was surprised at the cavalier reaction of some geologists. Half the buildings on the University of California campus at Berkeley were unsafe, as were those at Stanford. When Gerhard Casper became President at Stanford he asked me if he should be worry about an earthquake. I told him that he should, and the buildings were retrofitted with anti-twist frames costing about \$200 million. Even now, many buildings in Los Angeles and the Bay areas are not safe because they would not resist the twisting motion that occurs in major earthquakes.

In 1969, at the University of Chicago, certain students started a sit-in at the Administration Building to protest the university giving information to the federal government on student grades relevant to military service in Vietnam. Unfortunately, the protest got out of hand, and a court was set up to discipline the errant students. To minimize disruptions, Ole Kleppa and I set up a quiet group of faculty and wives. We occupied every other seat in the courtroom. I became identified as an organizer, and one of the students sat next to me and asked if my wife went out by herself with the implication that she was in danger. I went to the College office and identified the student from the photo records. The next day he made the same threatening remarks. I wrote his name on a piece of paper without looking at him, and he left, never to return. I organized an overnight guard for our equipment in the Hind Laboratory to avoid deliberate destruction that happened on other campuses.

A personal problem became a growing allergy to tobacco smoke. Nicotine is a potent drug, and it took me several years to quit after reading about the correlation between smoking and various diseases. In general, it turns out that *on average, but not in detail*, each cigarette takes about six minutes of a life. I managed first to get down to about six cigarettes per day, with an occasional cigar. Finally one day my wife told me that my tobacco-breath was so obnoxious that it was cigars or intimacy with her. I stopped smoking immediately. After that I developed an allergy to other people's smoke. This posed real problems because all meetings on campus had smokers chuffing away. The introductory meetings at national conferences

were called “Smokers”, and so on. My wife and I began to spend more time at smoke-free music concerts, the theater and art museums as a compensation for not going to parties. This turned out to be a good thing as we learnt about prints at the Art Institute and bought a series at the Chicago Symphony Orchestra. At that time non-smokers were thought to be strange people, and it is only 40 years later that non-smoking is regarded as sensible. Unfortunately, tobacco is a very potent drug, and about one-fifth of the population seems to find it impossible to break the habit until medical problems become too severe. Many of my friends have succumbed to tobacco, including Scott MacKenzie.

My father understood ecology at the level of his farm in relation to his village compatriots, but he knew nothing about wider environments. He insisted on keeping the hedges as homes for the birds. He limited the application of artificial fertilizer in favor of cow manure. Modern farming has gone overboard in the use of fertilizer, pesticides and herbicides, and the population of butterflies and birds in Derbyshire is much less than when I was a boy. For many years in the 1950’s and 60’s I would walk the hedges and field walls to identify the plants I knew as a boy. By the 1970’s, most of the rare ones had gone. . . .

Particularly important to me at this time was a growing interest in ecology. This is a modern word for an old subject (the mutual relations between organisms and their environment) that became popular as *Homo industrialis* modified the Earth’s surface so much faster than before. . . .

In a one-day field trip, I took students through the changing ethnicity of the lakefront of south Chicago, described by Barack Obama; the oil refineries of Hammond and Whiting IN; and the huge steel complexes with their modern waste-treatment lagoons and waste dumps (brownfields). Moving east past the US Steel city of Gary and Miller, we passed further steel complexes alternating with parts of the Indiana Dunes National Lakeshore, where we saw a beaver house and flocks of migrating birds. We crossed Burns Ditch dug in 1926 to drain a hundred square kilometers of swamp. We went to the Bailly Homestead, the home of the first trading post in northern Indiana, served by canoe on the Little Calumet River, and Chellberg Farm, once the home of early Swedish settlers, in the glacial moraine. Finally, we went east along the Glenwood 13,000 year dune-beach complex, then north across the Calumet 10,000 year complex, crossing the inter-dune swamp into the Tolleston-Algonquin 7,000 year complex. This merges into the Algoma-Nipissing complex that abuts the lake. We entered the Indiana Dunes State Park at the southeast corner of trail 10, identifying skunk cabbage, tulip trees, cottonwoods and junipers as well as the common black oaks and white pines. We climbed a steep trail and entered the Big Blowout, where the wind was still blowing away sand in the bare crater left by the big fire that burnt out the stabilizing grape vines and other



Joe by a wallside on Birchwood Farm.

low shrubs and trees. Returning to the beach, we were able to interpret the ripples and pebble beds in terms of wind action during the past week, and the cut-away fore dunes in relation to the winter storms of an unusually high lake. Returning south we observed the marram grass colonizing the wind-blown sand, the jack pines on the frigid north slopes, and the sequence of flora originally interpreted by Cowles and re-interpreted by Olson. Looking east from a high point we saw the erosion to the west of the Michigan City pier caused by blocking of the underwater flow of sand. Returning westward to Chicago we saw the hole left by the abandoned nuclear power station, and looked at the meandering rivers, whose route had been changed during construction of the steel mills.

This field trip covered so much of the importance of geological details for the welfare of so many humans together with the animals and birds. More recently an explosion of the deer has caused vigorous discussion of what to do, ranging from nothing to culling. In Beverly Shores IN, bow hunting was authorized and this has cut down the deer but not sufficiently to save all the plants and bushes eaten by them. It is becoming obvious that humans will have to manage their environment in a sensitive way. Planting a million trees per year is a very positive step for the city of Chicago. Perhaps it will be wise for everyone to plant trees in as many places as possible to soak up carbon dioxide. Then it will be necessary to cut down scrub to minimize the danger of forest fires. Foreign plants such as garlic mustard have run riot because of absence of predators, but ultimately some local animals must in desperation begin to eat them. Foreign marine organisms have similarly caused great problems with the fish in the great lakes.

Driving from Chicago to Boston provides many illustrations of the importance of planning for human welfare. Northwest Indiana and western Ohio are full of farms with no obvious degradation of the landscape, except of course the effects of replacing grass and trees by open fields. Cleveland is patchy, ranging from old industrial wasteland to beautiful museums. Western Pennsylvania is full of grape vines, southwest New York is charming, with industrial damage only around Corning and other cities. Staying northerly, one drives past Albany and Springfield, with wonderful mountain vistas and small abandoned mill towns. In general, New England is full of people but not on the scale of Europe and Britain. Just a few miles from any city, one can get way into the parks and raw country. Abandonment of pioneer farms can be seen, as farmers moved westward. However, it is difficult to find roads without strip development as city people have moved to take advantage of the country environment. Particularly important is the expansion of the forest in New England that is compensating somewhat for the blanket cut-downs out west.

So a key thing for this book is the growing recognition of the complexity of the ecology from place to place, and the speed of the changes that occur. In 2007, a drive from Boston to the west coast shows many changes including build-up of forests, some clean-up of old industrial areas, and major expansion of cities into the countryside. In the UK, land availability is much tighter, and old industrial areas are more polluted than the USA.

Chapter 7

Research Professor Explores the Mantle and Continues with Other Research

1975-1985

In 1975, I began publishing a series of 50 papers with J. Barry Dawson on minerals and rocks from the lower crust and upper mantle. Barry had been studying geology (for a degree from Leeds University) in East Africa where he described the first alkali carbonatite lava flow at the Oldoinyo Lengai volcano. Both of us attended the First Kimberlite Conference in South Africa where we collected a series of rock fragments of peridotite, eclogite and our newly-recognized Mica-Amphibole-Rutile-Ilmenite-Diopside suite. One mica-garnet lherzolite actually contained a twinned diamond in situ, indicating crystallization at a depth greater than 160 kilometers, followed by travel to the Earth's surface at near-supersonic speed to avoid regression of the diamond to graphite. The MARID suite was explained by crystallization in pods of volatile magma analogous to pegmatites in near-surface granites.

Visiting Barry Dawson at St Andrews and later at Edinburgh in Scotland allowed me to continue learning the history of geology so nicely assembled by J Repcheck in *The Man who Found Time: James Hutton and the Discovery of the Earth's Antiquity*.

Work continued with Brian Windley on early metamorphic igneous complexes to provide a comparison with lunar rocks, and on meteorites with Ian Steele. A nice idea came when Brian, Bob Newton and I asked how the first continents became stable. In a wet condition, melting occurs at low temperature, but in carbon dioxide the melting does not occur until a great depth is reached. Hence we proposed that the

first continents became stable when carbon dioxide from the mantle had flushed out the water leaving the granulite type of high-grade metamorphic rocks found so nicely in the Deccan Plateau of India and elsewhere. Another nice idea came when Barry and I asked where carbonado diamonds came from. We proposed that they are the relics of impact on early graphite-rich sediments in which the shock wave had converted the graphite into an intimate irregular mixture of diamond and lonsdaleite (a stacking variant AB of diamond resulting from the lack of time to change completely to the stabler diamond ABC structure during the passage of the shock wave).



Field trip to The Grand Canyon. Joe is third from the right, and the only sober one!

A major problem with the Kimberlite Conference was the apartheid system in South Africa. On landing in Johannesburg, we had to go through doors labeled Blanke for whites only. In Kimberley, one day I went through the Blanke door of a bank, to find only one teller on duty. Blacks and whites formed a single line as they came through their respective doors. At our Cape Town hotel the bus driver went all shades of red when told that the man he commanded to load the bags was actually an Indian delegate from Uganda. Another problem was that De Beers violated USA laws in establishing a worldwide regulated market for diamonds, settled only in 2004 by payment of a large fine. At a de Beers party, a beautiful woman with a bad complexion from the low humidity (my nose oozed blood) figured I was of low account when I told her that I had no servants at home, and that Brenda and I did the cleaning between us. A de Beers executive told me that they could not appoint blacks to positions of authority where white men would have to work under them. At the Kimberley sorting office, we saw heaps of diamonds of almost every

color. One diamond-bearing eclogite was presumed to be pocketed by a conference member, whose identity could not be located. Truly great were the field trips to the kimberlite pipes. Barry and I spent many hours working over the surface and rubble heaps selecting likely looking prospects. At night, there were rugby-football style parties where huge amounts of liquor were consumed. Henry Emeleus and I were party poopers. At the final conference in Cape Town on the last morning there were only a dozen delegates capable of sitting up straight in their seats. The old British tradition of excessive consumption of alcohol took its toll.



Joe clambering up a rock on a field trip to the Grand Canyon.

Putting together all the research on kimberlites, the early crust, the Moon and meteorites, it was obvious that there was no simple story. As a result, I wrote several review articles suggesting that heterogeneous accretion had occurred on a hot Earth that had not fully equilibrated and still retained a little evidence of a reduced early state. This was then capped by rocks of increasing oxidation as hydrogen was lost, and material came in from the outer solar system. The early Earth would have been very hot from the kinetic energy of accretion together with the high radioactive heat. It would have bubbled like a dish of porridge with most of the earth looking like the Iceland volcanic zone of the present day. Only after five hundred million years would it have settled down enough to develop pieces of stable crust of which fragments survive to the present day but strongly metamorphosed. The recent series of articles in *Elements* 2(4) edited by JW Valley put it all together very nicely.

Research on zeolite molecular sieves continued with many new structures determined by Joe Pluth

and others. Particularly interesting was the determination with Union Carbide scientists of the structure of a polymorph of silica named silicalite, the analog of a useful adsorbent and catalytic material called ZSM-5 by Mobil Corporation. This Si-end member of an Al-bearing zeolite turned out to be very attractive to organic molecules capable of entering its 3D 10-ring channel system. Many years later, mutinaite was found in the Antarctic, and its silicalite framework turned out to provide a possible key step in biological evolution in that we now had a way to adsorb amino acids and energy molecules on a wet catalytic surface and potentially get RNA, DNA & ADP/ATP started. . . .

Chapter 8

Advanced Radiation Sources; Geology and Human Welfare

1987-2005

From 1987 on, my scientific life became increasingly tied to synchrotron X-ray sources that have allowed a revolution in mineralogy, geochemistry and the materials and environmental sciences. Whereas the traditional X-ray and infra-red sources wasted most of the power, the high-speed electrons of a synchrotron emit polarized narrow jets, each jet being capable of being focused on a specimen. The first generation of synchrotron sources was merely piggy-backed off high-energy nuclear accelerators. The second generation was deliberately built to optimize the X-ray or infrared beams. A representative pair of such sources is the National Synchrotron Light Source facility at Brookhaven National Laboratory, Long Island, NY. I became the Principal Investigator for a million-dollar NSF-Geochemistry grant to set up a national facility for X-ray fluorescence analysis at beamline X-26. This led to a long-standing highly productive collaboration with Keith Jones of BNL, and the enjoyable employment of Mark Rivers and Steve Sutton.

Also, I collaborated with Jim Richardson at the Intense Pulsed Neutron Source at Argonne National Laboratory and with Åke Kvik at the Brookhaven High Flux Neutron Source to determine crystal structures of zeolites and other silicates. Because neutrons scatter very weakly, it was necessary to find single crystals a centimeter across, and to exchange the hydrogen with deuterium to remove the background scatter. Years of looking at zeolites in mineral museums allowed selection of crystals from which we hoped to determine the butterfly shape of water molecules. It turned out that the water molecules in zeolites are rocking and the amount of rocking increases with the increasing size of the cavity and the number of molecules in the zeolite.

For beamline NSLS-X26, we found that we could determine the oxidation state of many individual elements down to a few parts per million for a spot size of about 10 micrometers (much smaller than the width of a human hair). This opened up a world of new studies ranging from diffusion profiles of

metallic elements in metallic meteorites; the valence state of manganese in black smut in the “take-all” disease of wheat; and the valence state of toxic elements like arsenic. A group of investigators have picked up on these opportunities, and a huge number of scientific reports can be found.



Joe pointing out a fossil in a building on Riverside Drive, New York City, near Ginnie's apartment.

From 1985 on, I became involved in national planning for advanced radiation sources. The National Academy of Sciences appointed a committee to evaluate the future. It was widely believed that it would be impossible to get agreement between advocates for different machines across the country. However, under the careful tutelage of Frederick Seitz and Don Eastman a solution was hammered out. The highest priority was given to a third-generation X-ray source of high energy and a special type of low-energy X-ray source plus a high-intensity pulsed neutron source. Because of politics focused on California, the low-energy X-ray source was funded first and became the Advanced Light Source at Lawrence Berkeley Laboratory. Competition for the high-energy source was very keen, and after intense discussions it was finally assigned as the Advanced Photon Source at Argonne National Laboratory managed by the University of Chicago. As the expert on synchrotron and neutron sources at the university, I was asked by Walter Massey and Stuart Rice to take charge of building a facility at the APS. This was a tough request at the age of 60, because I had many years of research to complete. After discussing things with Brenda, we decided that I must comply, and this set me off on a 12-16-hour business-oriented day for the next five years, ultimately being able to turn over completion of the facility to Keith Moffat, Mark Rivers, Steve Sutton, James Viccaro and Joy Talsma.

Currently, the Center for Advanced Radiation Sources comprises three sectors each with multiple beam-lines that lead the World in research activities in their areas. Financing CARS required intense

activity. The GeoEnviroSci sector 13 is funded by the National Science Foundation and Department of Energy geochemistry programs, and currently is heavily oversubscribed. The Bio sector 15 is funded by the National Institute of Health and concentrates on fast reactions in biochemistry. Sector 14 for Chem/Mat is just coming up to speed and is funded mainly by NSF. Over the past 15 years, 100 million dollars have been raised from a variety of sources, including the State of Illinois and Australia. Currently, it is possible to do trace-element analysis on 2 micrometer spots; determine the crystal structure of crystals as small as a few micrometers; do high-pressure research with diamond-anvil cells at conditions mimicking the upper and lower mantle; do surface chemical profiles with the resolution of one-tenth of an atomic layer; and determine chemical changes on the time scale of a microsecond to a few nanoseconds.

As Coordinator of Scientific Programs, it was necessary for me to keep up with research across the physical and biological sciences. For each scientific area, we established a supervisory committee of national experts in the fields of Geosciences, Biology, Chemistry and Material Sciences, and Physics.

During the 5 years of setting up CARS, there were meetings almost twice a month at weekends to save travel money. I spent many days on planes, including round trips to Long Island with travel starting at 5 AM and return at 11 PM, with a class to teach the next morning. Most faculty members were neutral or negative, but I was accused of building an empire for myself. My department head worried that I might be neglecting my duties to students but the Dean knew otherwise. To maintain my temper, I pulled weeds in my garden on Saturday mornings with different weeds assigned to the most obnoxious faculty ideas. Fortunately the support from around the country and the world was fantastic, and we established excellent collaborations with scientists at synchrotron sources in the UK, France and Japan.

In 2006, CARS still have not achieved a special sector for environmental studies, and our efforts in art and archaeology are also promising but unfunded. No doubt success will be achieved later on when funding becomes easier.

After 5 years of heavy labor, I was set free to teach and do research again. The college course for geosciences for nonscientists was in trouble, and I felt obliged as senior faculty member to take it on. Over three years, I was able to bring it up to speed by concentrating on Geology and Human Welfare. It was given in the Spring Quarter when students were concentrating on other things. Nevertheless, I was able to get most of the students to class, and in the final year of the course, I was able to give 80% A's and B's on an absolute grading level. The course covered much of the material in this book, with emphasis on what geologic factors were important for human health. Teaching the students was a challenge. Most of them had no deep training in science, but were very bright in other subjects. Most could write a nice essay. The students were equally divided between the sexes, and came from across the World. Particularly, I liked working with students of both sexes and of skin color different from my own. I received nice postcards as they traveled telling me how they were looking at mountains and other geologic features in new ways. Unfortunately, a new college system came in when I gave up teaching with the college courses fixed at two instead of the original three quarters, and the Spring course in geoscience disappeared.

Research became a problem because of lack of time to follow all the new ideas I had developed as CARS Director. I had to concentrate on just a few and hope that my health would survive long enough. I was able to find time to publish a monograph on the connectivity of the tetrahedral nets in zeolites and

other frameworks, but was unable to find time to move on to nets based on octahedral and other linkages.

For feldspars, I came up with an idea to explain why feldspar and quartz weathered in granites at about the same rate whereas laboratory studies indicate that quartz is much more stable. The answer is that in Nature the surface of the feldspar *slowly* loses its unstable aluminum and alkali atoms and the remaining Si and oxygen atoms becomes organized as in quartz. In the laboratory, *the experiments were too rapid for the surface to adjust so that the acidic solution kept eating away at the feldspar*. In principle this can be checked on the facilities run by CARS. but no detailed measurements have yet been made. This slow degree of surface adjustment may also be important in industry. It should be possible to adjust the surface of glass in windshields and windows to be silica-rich again matching quartz thus making them shed water and stay cleaner.



Joe and Brenda at their 50th wedding anniversary at The Jovial Dutchman, Crich, in the summer of 2001.

From the viewpoint of surface chemistry, another idea came up. Darwin's pond poses problems for getting evolution started. Water blocks the linkage to clay mineral surfaces of organic molecules, as originally proposed implicitly. A certain rare zeolite *mutinaite* from Antarctica matches ZSM-5 a synthetic material made by Mobil Corporation. The Union Carbide *silicalite* end-member of the ZSM-5 series is a pure silica material and has the capacity to extract very low concentrations of organic molecules from water. Hence one can imagine *mutinaite* being formed by hydration of feldspars in early volcanic rocks, losing its aluminum atoms to become like *silicalite*, and absorbing amino acids and other important biological molecules in its 10-ring channels. If it kept a few Al atoms, it would keep the catalytic capacity of ZSM-5. One can imagine a pond with water slopping back and forth in response to very strong tidal

action from a close-in Moon. When wet, the silica-rich mutinaite would adsorb amino acids and other organics. When dried in the Sun, catalytic actions would proceed. Volcanic feldspar carries up to half a percent of phosphorus. As the feldspar weathers, it would release phosphorus oxyhydroxide all ready for hooking up with organic molecules to make the energy molecules ADP and ATP. These catalytic actions have been simulated on a computer, but have not been tested yet experimentally. Of course, the uncertainty in these applications have allowed the non-scientific members of the anti-Darwin evolution group to claim that only God, whoever he is, controlled the early stages of evolution.

While teaching Geology and Human Welfare, I asked why humans seemed to have evolved in east Africa. I phoned Barry Dawson in Edinburgh once a week for two months, and we came up with the idea that it was related to special types of volcanism. This led to ideas on Darwinian evolution throughout geologic time. When water and sun are available, the supply of food is ultimately related to the richness of soil and the abundance of biological elements. Volcanism produces a variety of compositions ranging from the common basalts to a few alkali-rich ones rich in the biological elements. East Africa is particularly rich in alkali-rich volcanic rocks and various carbonatites. It has rainfall throughout the year and has had a tremendous range of climatic conditions from glaciers on the highest volcanoes to savannahs and tropical rain forests only a few tens of miles away. This rich environment is good for development of a cluster of species with different niches of which humans happened to become the most adaptable. Going back in time, one can imagine the Earth being shaken up by big impacts triggering off the release of magmas from inside. Again, in certain places alkali-rich volcanoes would be emitting lavas rich in biological elements, and those in tropical regions would be best for Darwinian evolution. These ideas have not yet been approved in detail for publication in peer-reviewed journals, (the tragic death of Barry's wife has delayed our publications), but the following paper contains the essence: Jvs 2005 *Geochemical influences on life's origins and evolution*, Elements 1 151-6 (described in PJ Wyllie's article in *Earth Sciences*, Encyclopedia Britannica 2006 Book of the Year 167-8).

I spent most of 2005 and 2006 getting set up in Brookline, Massachusetts while recovering from continuing Parkinson's disease and major operations involving broken hip and heart attacks. I hope that 2007 will allow improved time. This sets the scene then for Part II which uses so many of the scientific and non-scientific ideas from Part I.

Part II

Dangers & Remedies

[This material is not part of this edited version of Living Safely; it is included to show the extent of the complete manuscript]

- 1. Taking Care: Medical Dangers**
- 2. Watch It: Everyday Accidents**
- 3. Collective Madness: Wars and Civil Strife**
- 4. People Galore: Population Growth**
- 5. Flying Blind: Comets and Asteroids**
- 6. Bubbling Cauldrons: Volcanoes**
- 7. Rock and Roll: Earthquakes**
- 8. Wet and Windy: Tsunamis, Storms and Floods**
- 9. Slipping Away: Landslides and Avalanches**
- 10. Blowing Hot and Cold: Climate & Weather Changes; Atmospheric Pollution**
- 11. Energy Uses**
- 12. Putting it Together: Some Examples**
- 13. The Right Choices: International Planning**

APPENDIX 1

APPENDIX 2

BIBLIOGRAPHY

Part II

Dangers & Remedies

This second section takes ideas in the first section, expands them, and evaluates the possible future actions needed for living safely. It compares geologic hazards with man-made ones, and concludes with a plan for different parts of the World beginning with Derbyshire and the Chicago areas. Much of what is written here can be considered in the realm of ecology and sustainability. The human race is a species that must learn to obey the constraints of population and uncertain food supply. A deliberate storage of food and a lowering of the population and energy use would go a long way to easing many of the worries about sustainability. Otherwise, humans might follow the fate of other species that expanded too much, and destroyed many other species too. Other earlier species on the Earth's surface have done well when they were able to maintain a stable life style. Over summer 2006 I have received much advice and have read many books. I am increasingly worried about the growth in population and energy use.

[100 pages follow that have been excised for this memoir/memory book.]



Joe with his children, Ginnie and Susan, in Pleasant Gap, Pennsylvania in 1956.



Joe with his grandchildren Katie, Jessica, and John in 2001 (Meg arrived in 2002).

This concludes the book, which is aimed at showing how a cautious farmer's boy from Derbyshire with advanced training at major universities assembled his views on how to live more safely. I hope that individual citizens as well as politicians, religious leaders and environmental planners will pick up on these ideas so that the next generations can live happy, productive and safe lives, with young people leading the way.—Joe



Some of Joe Smith's Favorite Poems

In Praise Of Limestone

W.H. Auden (May 1948)

If it form the one landscape that we, the inconstant ones,
 Are consistently homesick for, this is chiefly
 Because it dissolves in water. Mark these rounded slopes
 With their surface fragrance of thyme and, beneath,
 A secret system of caves and conduits; hear the springs
 That spurt out everywhere with a chuckle,
 Each filling a private pool for its fish and carving
 Its own little ravine whose cliffs entertain
 The butterfly and the lizard; examine this region
 Of short distances and definite places:
 What could be more like Mother or a fitter background
 For her son, the flirtatious male who lounges
 Against a rock in the sunlight, never doubting
 That for all his faults he is loved; whose works are but
 Extensions of his power to charm? From weathered outcrop
 To hill-top temple, from appearing waters to
 Conspicuous fountains, from a wild to a formal vineyard,
 Are ingenious but short steps that a child's wish
 To receive more attention than his brothers, whether
 By pleasing or teasing, can easily take.

Watch, then, the band of rivals as they climb up and down
 Their steep stone gennels in twos and threes, at times
 Arm in arm, but never, thank God, in step; or engaged
 On the shady side of a square at midday in
 Voluble discourse, knowing each other too well to think
 There are any important secrets, unable
 To conceive a god whose temper-tantrums are moral
 And not to be pacified by a clever line
 Or a good lay: for accustomed to a stone that responds,
 They have never had to veil their faces in awe
 Of a crater whose blazing fury could not be fixed;
 Adjusted to the local needs of valleys
 Where everything can be touched or reached by walking,
 Their eyes have never looked into infinite space
 Through the lattice-work of a nomad's comb; born lucky,
 Their legs have never encountered the fungi
 And insects of the jungle, the monstrous forms and lives
 With which we have nothing, we like to hope, in common.
 So, when one of them goes to the bad, the way his mind works
 Remains incomprehensible: to become a pimp
 Or deal in fake jewellery or ruin a fine tenor voice
 For effects that bring down the house, could happen to all
 But the best and the worst of us...

That is why, I suppose,
 The best and worst never stayed here long but sought
 Immoderate soils where the beauty was not so external,
 The light less public and the meaning of life

Something more than a mad camp. 'Come!' cried the granite wastes,
 "How evasive is your humour, how accidental
 Your kindest kiss, how permanent is death." (Saints-to-be
 Slipped away sighing.) "Come!" purred the clays and gravels,
 "On our plains there is room for armies to drill; rivers
 Wait to be tamed and slaves to construct you a tomb
 In the grand manner: soft as the earth is mankind and both
 Need to be altered." (Intendant Caesars rose and
 Left, slamming the door.) But the really reckless were fetched
 By an older colder voice, the oceanic whisper:
 "I am the solitude that asks and promises nothing;
 That is how I shall set you free. There is no love;
 There are only the various envies, all of them sad."

They were right, my dear, all those voices were right
 And still are; this land is not the sweet home that it looks,
 Nor its peace the historical calm of a site
 Where something was settled once and for all: A back ward
 And dilapidated province, connected
 To the big busy world by a tunnel, with a certain
 Seedy appeal, is that all it is now? Not quite:
 It has a worldly duty which in spite of itself
 It does not neglect, but calls into question
 All the Great Powers assume; it disturbs our rights. The poet,
 Admired for his earnest habit of calling
 The sun the sun, his mind Puzzle, is made uneasy
 By these marble statues which so obviously doubt
 His antimythological myth; and these gamins,
 Pursuing the scientist down the tiled colonnade
 With such lively offers, rebuke his concern for Nature's
 Remotest aspects: I, too, am reproached, for what
 And how much you know. Not to lose time, not to get caught,
 Not to be left behind, not, please! to resemble
 The beasts who repeat themselves, or a thing like water
 Or stone whose conduct can be predicted, these
 Are our common prayer, whose greatest comfort is music
 Which can be made anywhere, is invisible,
 And does not smell. In so far as we have to look forward
 To death as a fact, no doubt we are right: But if
 Sins can be forgiven, if bodies rise from the dead,
 These modifications of matter into
 Innocent athletes and gesticulating fountains,
 Made solely for pleasure, make a further point:
 The blessed will not care what angle they are regarded from,
 Having nothing to hide. Dear, I know nothing of
 Either, but when I try to imagine a faultless love
 Or the life to come, what I hear is the murmur
 Of underground streams, what I see is a limestone landscape.

The Road Not Taken
Robert Frost (1915)

Two roads diverged in a yellow wood,
 And sorry I could not travel both
 And be one traveler, long I stood
 And looked down one as far as I could
 To where it bent in the undergrowth.

Then took the other, as just as fair,
 And having perhaps the better claim,
 Because it was grassy and wanted wear;
 Though as for that the passing there
 Had worn them really about the same.

And both that morning equally lay
 In leaves no step had trodden black.
 Oh, I kept the first for another day!
 Yet knowing how way leads on to way,
 I doubted if I should ever come back.

I shall be telling this with a sigh
 Somewhere ages and ages hence:
 Two roads diverged in a wood, and I--
 I took the one less traveled by,
 And that has made all the difference.

Fire and Ice
Robert Frost

Some say the world will end in fire,
 Some say in ice.
 From what I've tasted of desire
 I hold with those who favor fire.
 But if it had to perish twice,
 I think I know enough of hate
 To say that for destruction ice
 Is also great
 And would suffice.

Hoeing
John Updike

I sometimes fear the younger generation will be
 deprived
 of the pleasures of hoeing;
 there is no knowing
 how many souls have been formed by this simple
 exercise.

The dry earth like a great scab breaks, revealing
 moist-dark loam—
 the pea-root's home,
 a fertile wound perpetually healing.

How neatly the green weeds go under!
 The blade chops the earth new.
 Ignorant the wise boy who
 has never rendered thus the world fecunder.

On First Looking into Chapman's Homer
John Keats, 1795-1821

Much have I travell'd in the realms of gold,
 And many goodly states and kingdoms seen;
 Round many western islands have I been
 Which bards in fealty to Apollo hold.
 Oft of one wide expanse had I been told
 That deep-brow'd Homer ruled as his demesne;
 Yet did I never breathe its pure serene
 Till I heard Chapman speak out loud and bold:
 Then felt I like some watcher of the skies
 When a new planet swims into his ken;
 Or like stout Cortez when with eagle eyes
 He star'd at the Pacific—and all his men
 Look'd at each other with a wild surmise—
 Silent, upon a peak in Darien.

Granite
John Updike

New England doesn't kid around;
 It wears its bones outside.
 Quartz-freckled, time-rumpled granite—
 Your tombstone everywhere.

At night I wake and warily gaze
 At outcroppings on my lawn.
 These moonlit humpbacks, do they sleep
 Or do their blanched surfaces sense my eyes?
 By day, you can see how earth
 Engenders itself over aeons—
 Pine needles silt in, and tender weeds
 Take hold in the cracks, then wild roses

And hairy-stemmed sumacs find enough
 For a footing, and oak rootlets,
 And out of the mesh comes a mulch, a soil—
 Trapped particles breed trapped life.

There is no way not to die,
 Can it be? What do these stones
 Coldly know? Or is moonlight warm,
 And the granite a pledge

To which consciousness clints?
 Better rock than the mud
 Of a meaningless mercy, such as men
 Would devise. This outcrop

Is a wide gray glow the night has grown.
 I think with awe of the man
 Who will gaze down upon it, awake,
 when I'm blinder than stone.

The Crack
Michael Goldman

There is a private tension that endears
 The opposed split sides of a granite block;
 Some deep affinity decides the rock
 When the first fault or wavering edge appears,
 And the grained flaw grows jaggeder as it nears
 The face that someone beat upon or broke
 In art or anger. Sometimes at such a crack
 All holds; so luck, so lovingly, coheres.

I saw a Lipchitz Mother straining once
 To embrace the air, made jagged by her grace,
 And Lipchitz said that he had meant the stone
 Merely to test his tools, but had begun
 Serious work on staring at a face
 His hammer had laid bare by luck alone.

Ode to Crystallization
John Updike

The atom is a crystal
of a sort; the lattices
its interlockings form
lend a planarity most pleasing
to the abysses and cliffs, much magnified,
of (for example) salt and tourmaline.
Arise order,
out of necessity!
Mock, you crystals,
with all appearance of chiselled design,
our hope of a Grand Artificer.
The graceful, layered frost-ferns the midnight elves
left on the Shillington windowpanes
for my morning astonishment were misinformation,
as is
the glittering explosion of tinted quartz
discovered in earth like a nugget of thought,
buried evidence
crying out for release to the workman's pick,
tangled hexagonal hair of an angel interred
where it fell, our earth still molten, in the Fall.

When, on those anvils at the center of stars,
and those even more furious anvils
of the exploding supernovae,
the heavy elements were beaten together
to the atomic number of 94
and the crystalline metals with their easily lost
valence electrons arose,
their malleability and conductivity
made Assyrian goldsmithing possible
and most of New York City.

Stendhal thought that love
should be likened to a bare branch crystallized
by a winter in the depths of the salt mines of
Hallein:
"The tiniest twigs, no bigger
than a tomtit's claw, are spangled with an infinite
number of shimmering, glistening crystals."
Our mathematics and hope of Heaven
alike look to crystals;
their arising, the mounting
of molecules one upon the other, suggests
that inner freezing whereby inchoate
innocence compresses a phrase of art.

Music rises in its fixed lattices
and its cries of aspiration chill our veins
with snowflakes of blood;
the mind grapples up an inflexible relation
and the stiff spheres chime--
themselves, the ancients thought, all crystal.
In this seethe of hot muck there is something else:
the ribs of an old dory emerge from the sand,
the words set their bevelled bite on the page,
the loved one's pale iris flares in silent assent,
the electrons leap, leaving positive ions
as the fish scales of moonlight show us water's
perfect dance.
Steno's Law, crystallography's first:
the form of crystal admits no angle but its own.

Mowing
Robert Frost

There was never a sound beside the wood but one,
And that was my long scythe whispering to the
ground.
What was it it whispered? I knew not well myself;
Perhaps it was something about the heat of the sun,
Something, perhaps, about the lack of sound
And that was why it whispered and did not speak.
It was no dream of the gift of idle hours,
Or easy gold at the hand of fay or elf:
Anything more than the truth would have seemed
too weak
To the earnest love that laid the swale in rows,
Not without feeble-pointed spikes of flowers
(Pale orchises), and scared a bright green snake.
The fact is the sweetest dream that labour knows.
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My long scythe whispered and left the hay to make.

The Prairies (excerpt)
William Cullen Bryant, 1832

These are the gardens of the Desert, these
 The unshorn fields, boundless and beautiful,
 For which the speech of England has no name-
 The Prairies. I behold them for the first,
 And my heart swells, while the dilated sight
 Takes in the encircling vastness. Lo! they stretch,
 In airy undulations, far away,
 As if the ocean, in his gentlest swell,
 Stood still, with an his rounded billows fixed,
 And motionless forever.- Motionless?-
 No- they are all unchained again. The clouds
 Sweep over with their shadows, and, beneath,
 The surface rolls and fluctuates to the eye;
 Dark hollows seem to glide along and chase
 The sunny ridges. Breezes of the South!
 Who toss the golden and the flame-like flowers,
 And pass the prairie-hawk that, poised on high,
 Flaps his broad wings, yet moves not- ye have played
 Among the palms of Mexico and vines
 Of Texas, and have crisped the limpid brooks
 That from the fountains of Sonora glide
 Into the calm Pacific- have ye fanned
 A nobler or a lovelier scene than this?
 Man hath no power in all this glorious work:
 The hand that built the firmament hath heaved
 And smoothed these verdant swells, and sown their slopes
 With herbage, planted them with island groves,
 And hedged them round with forests. Fitting floor
 For this magnificent temple of the sky-
 With flowers whose glory and whose multitude
 Rival the constellations! The great heavens
 Seem to stoop down upon the scene in love,-
 A nearer vault, and of a tenderer blue,
 Than that which bends above our eastern hills. . . .

The Village Blacksmith
Henry Wadsworth Longfellow. 1807–1882

Under a spreading chestnut tree
 The village smithy stands;
 The smith, a mighty man is he,
 With large and sinewy hands;
 And the muscles of his brawny arms
 Are strong as iron bands.

His hair is crisp, and black, and long,
 His face is like the tan;
 His brow is wet with honest sweat,
 He earns whate'er he can,
 And looks the whole world in the face,
 For he owes not any man.

Week in, week out, from morn till night,
 You can hear his bellows blow;
 You can hear him swing his heavy sledge
 With measured beat and slow,
 Like a sexton ringing the village bell,
 When the evening sun is low.

And children coming home from school
 Look in at the open door;
 They love to see the flaming forge,
 And hear the bellows roar,
 And watch the burning sparks that fly
 Like chaff from a threshing-floor.

He goes on Sunday to the church,
 And sits among his boys;
 He hears the parson pray and preach,
 He hears his daughter's voice,
 Singing in the village choir,
 And it makes his heart rejoice.

It sounds to him like her mother's voice,
 Singing in Paradise!
 He needs must think of her once more,
 How in the grave she lies;
 And with his hard, rough hand he wipes
 A tear out of his eyes.

Toiling,—rejoicing,—sorrowing,
 Onward through life he goes;
 Each morning sees some task begin,
 Each evening sees it close;
 Something attempted, something done,
 Has earned a night's repose.

Thanks, thanks to thee, my worthy friend,
 For the lesson thou hast taught!
 Thus at the flaming forge of life
 Our fortunes must be wrought;
 Thus on its sounding anvil shaped
 Each burning deed and thought!

To the Stone-Cutters
Robinson Jeffers (1887-1962)

Stone-cutters fighting time with marble, you
 foredefeated
 Challengers of oblivion
 Eat cynical earnings, knowing rock splits, records
 fall down,
 The square-limbed Roman letters
 Scale in the thaws, wear in the rain. The poet as
 well
 Builds his monument mockingly;
 For man will be blotted out, the blithe earth die, the
 brave sun
 Die blind and blacken to the heart:
 Yet stones have stood for a thousand years, and
 pained thoughts found
 The honey of peace in old poems.

Matlock Bath
Sir John Betjeman

From Matlock Bath's half-timbered station
 I see the black dissenting spire
 Thin witness of a congregation,
 Stone emblem of a Handel choir;
 In blest Bethesda's limpid pool
 Comes treacling out of Sunday School.

By cool Siloam's shady rill
 The sounds are sweet as strawberry jam
 I raise mine eyes unto the hill,
 The beetling Heights of Abraham;
 The branchy trees are white with rime
 In Matlock Bath this winter-time,

And from the whiteness, grey uprearing,
 Huge cliffs hang sunless ere they fall,
 A tossed and stony ocean nearing
 The moment to o'erwhelm us all
 Eternal Father, strong to save,
 How long wilt thou suspend the wave?

How long before the pleasant acres
 Of intersecting Lovers' Walks
 Are rolled across by limestone breakers,
 Whole woodlands snapp'd like cabbage stalks?
 O God, our help in ages past,
 How long will Speedwell Cavern last?

In this dark dale I hear the thunder
 Of houses folding with the shocks,
 The Grand Pavilion buckling under
 The weight of the Romantic Rocks,
 The hardest Blue John ash-trays seem
 To melt away in thermal steam.

Deep in their Nonconformist setting
 The shivering children wait their doom
 The father's whip, the mother's petting
 In many a coffee-coloured room;
 And attic bedrooms shriek with fright,
 For dread of Pilgrims of the Night.

Perhaps it's this that makes me shiver
 As I ascend the slippery path
 High, high above the sliding river
 And terraces of Matlock Bath
 A sense of doom, a dread to see
 The Rock of Ages cleft for me.

Ode: Intimations of Immortality from Recollections of Early Childhood
(First Two Stanzas)
William Wordsworth. 1770–1850

The child is father of the Man
And I could wish my days to be
Bound each to each by natural piety

THERE was a time when meadow, grove, and stream,
 The earth, and every common sight,
 To me did seem
 Apparell'd in celestial light,
 The glory and the freshness of a dream.
 It is not now as it hath been of yore;—
 Turn wheresoe'er I may,
 By night or day,
 The things which I have seen I now can see no more.

 The rainbow comes and goes,
 And lovely is the rose;
 The moon doth with delight
 Look round her when the heavens are bare;
 Waters on a starry night
 Are beautiful and fair;
 The sunshine is a glorious birth;
 But yet I know, where'er I go,
 That there hath pass'd away a glory from the earth. . . .

The Tide Rises, the Tide Falls
Henry Wadsworth Longfellow.

The tide rises, the tide falls,
 The twilight darkens, the curlew calls;
 Along the sea-sands damp and brown
 The traveler hastens toward the town,
 And the tide rises, the tide falls.

Darkness settles on roofs and walls,
 But the sea, the sea in darkness calls;
 The little waves, with their soft, white hands
 Efface the footprints in the sands,
 And the tide rises, the tide falls.

The morning breaks; the steeds in their stalls
 Stamp and neigh, as the hostler calls;
 The day returns, but nevermore
 Returns the traveler to the shore.
 And the tide rises, the tide falls.

Rocky Acres
Robert Graves

This is a wild land, country of my choice,
With harsh craggy mountain, moor ample and bare.
Seldom in these acres is heard any voice
But the voice of cold water that runs here and there
Through rocks and lank heather growing without any care.
No mice in the heath run nor no birds cry
For fear of the dark speck that floats in the sky.

He soars and he hovers, rocking on his wings,
He scans his wide parish with a sharp eye,
He catches the trembling of small hidden things,
He tears them in pieces, dropping from the sky:
Tenderness and pity the land will deny
Where life is but nourished from water and rock,
A hardy adventure, full of fear and shock.

Time has never journeyed to this lost land,
Crakeberries and heather bloom out of date,
The rocks jut, the streams flow singing on either hand,
Careless if the season be early or late.
The skies wander overhead, now blue, now slate:
Winter would be known by his cold, cutting snow
If June did not borrow his armor also.

Yet this is my country beloved by me best,
The very first land that rose from Chaos and the Flood,
Nursing no fat valleys for comfort and rest,
Trampled by no hard hooves, stained with no blood.
Bold immortal country whose hill-tops have stood
Strongholds for the proud gods when on earth they go,
Terror for fat burghers in far plains below.

CHICAGO**Carl Sandberg**

HOG Butcher for the World,
 Tool Maker, Stacker of Wheat,
 Player with Railroads and the Nation's Freight Handler;
 Stormy, husky, brawling,
 City of the Big Shoulders:

They tell me you are wicked and I believe them, for I
 have seen your painted women under the gas lamps
 luring the farm boys.
 And they tell me you are crooked and I answer: Yes, it
 is true I have seen the gunman kill and go free to
 kill again.
 And they tell me you are brutal and my reply is: On the
 faces of women and children I have seen the marks
 of wanton hunger.
 And having answered so I turn once more to those who
 sneer at this my city, and I give them back the sneer
 and say to them:
 Come and show me another city with lifted head singing
 so proud to be alive and coarse and strong and cunning.
 Flinging magnetic curses amid the toil of piling job on
 job, here is a tall bold slugger set vivid against the
 little soft cities;

Fierce as a dog with tongue lapping for action, cunning
 as a savage pitted against the wilderness,
 Bareheaded,
 Shoveling,
 Wrecking,
 Planning,
 Building, breaking, rebuilding,
 Under the smoke, dust all over his mouth, laughing with
 white teeth,
 Under the terrible burden of destiny laughing as a young
 man laughs,
 Laughing even as an ignorant fighter laughs who has
 never lost a battle,
 Bragging and laughing that under his wrist is the pulse,
 and under his ribs the heart of the people,
 Laughing!
 Laughing the stormy, husky, brawling laughter of
 Youth, half-naked, sweating, proud to be Hog
 Butcher, Tool Maker, Stacker of Wheat, Player with
 Railroads and Freight Handler to the Nation.

Elegy Written in a Country Churchyard
Thomas Gray (1716–1771)

THE Curfew tolls the knell of parting day,
 The lowing herd wind slowly o'er the lea,
 The plowman homeward plods his weary way,
 And leaves the world to darkness and to me.

Now fades the glimmering landscape on the sight,
 And all the air a solemn stillness holds,
 Save where the beetle wheels his droning flight,
 And drowsy tinklings lull the distant folds;

Save that from yonder ivy-mantled tow'r
 The moping owl does to the moon complain
 Of such as, wand'ring near her secret bow'r,
 Molest her ancient solitary reign.

Beneath those rugged elms, that yew-tree's shade,
 Where heaves the turf in many a mould'ring heap,
 Each in his narrow cell for ever laid,
 The rude Forefathers of the hamlet sleep.

The breezy call of incense-breathing Morn,
 The swallow twitt'ring from the straw-built shed,
 The cock's shrill clarion, or the echoing horn,
 No more shall rouse them from their lowly bed.

For them no more the blazing hearth shall burn,
 Or busy housewife ply her evening care:
 No children run to lisp their sire's return,
 Or climb his knees the envied kiss to share.

Of t did the harvest to their sickle yield,
 Their furrow oft the stubborn glebe has broke:
 How jocund did they drive their team afield!
 How bow'd the woods beneath their sturdy stroke!

Let not Ambition mock their useful toil,
 Their homely joys, and destiny obscure;
 Nor Grandeur hear with a disdainful smile
 The short and simple annals of the poor.

The boast of heraldry, the pomp of pow'r,
 And all that beauty, all that wealth e'er gave,
 Awaits alike th' inevitable hour:
 The paths of glory lead but to the grave.

Nor you, ye Proud, impute to These the fault,
 If Memory o'er their Tomb no Trophies raise,
 Where through the long-drawn aisle and fretted
 vault
 The pealing anthem swells the note of praise.

Can storied urn or animated bust
 Back to its mansion call the fleeting breath?
 Can Honour's voice provoke the silent dust,
 Or Flatt'ry soothe the dull cold ear of death?

Perhaps in this neglected spot is laid
 Some heart once pregnant with celestial fire;
 Hands, that the rod of empire might have sway'd,
 Or waked to ecstasy the living lyre.

But Knowledge to their eyes her ample page
 Rich with the spoils of time did ne'er unroll;
 Chill Penury repress'd their noble rage,
 And froze the genial current of the soul.

Full many a gem of purest ray serene
 The dark unfathom'd caves of ocean bear:
 Full many a flower is born to blush unseen,
 And waste its sweetness on the desert air.

Some village Hampden that with dauntless breast
 The little tyrant of his fields withstood,
 Some mute inglorious Milton here may rest,
 Some Cromwell guiltless of his country's blood.

Th' applause of list'ning senates to command,
 The threats of pain and ruin to despise,
 To scatter plenty o'er a smiling land,
 And read their history in a nation's eyes,

Their lot forbade: nor circumscribed alone
 Their glowing virtues, but their crimes confined;
 Forbade to wade through slaughter to a throne,
 And shut the gates of mercy on mankind,

The struggling pangs of conscious truth to hide,
 To quench the blushes of ingenuous shame,
 Or heap the shrine of Luxury and Pride
 With incense kindled at the Muse's flame.

Far from the madding crowd's ignoble strife,
 Their sober wishes never learn'd to stray;
 Along the cool sequester'd vale of life
 They kept the noiseless tenor of their way.

Yet ev'n these bones from insult to protect
 Some frail memorial still erected nigh,
 With uncouth rhymes and shapeless sculpture
 deck'd,
 Implores the passing tribute of a sigh.

Their name, their years, spelt by th' unletter'd muse,
 The place of fame and elegy supply:
 And many a holy text around she strews,
 That teach the rustic moralist to die.

For who, to dumb Forgetfulness a prey,
 This pleasing anxious being e'er resign'd,
 Left the warm precincts of the cheerful day,
 Nor cast one longing ling'ring look behind?

On some fond breast the parting soul relies,
 Some pious drops the closing eye requires;
 Ev'n from the tomb the voice of Nature cries,
 Ev'n in our Ashes live their wonted Fires.

For thee, who, mindful of th' unhonour'd dead,
 Dost in these lines their artless tale relate;
 If chance, by lonely contemplation led,
 Some kindred spirit shall inquire thy fate,

Haply some hoary-headed Swain may say,
 'Oft have we seen him at the peep of dawn
 Brushing with hasty steps the dews away
 To meet the sun upon the upland lawn.

'There at the foot of yonder nodding beech
 That wreathes its old fantastic roots so high,
 His listless length at noontide would he stretch,
 And pore upon the brook that babbles by.

'Hard by yon wood, now smiling as in scorn,
 Mutt'ring his wayward fancies he would rove,
 Now drooping, woeful wan, like one forlorn,
 Or crazed with care, or cross'd in hopeless love.

'One morn I miss'd him on the custom'd hill,
 Along the heath and near his fav'rite tree;
 Another came; nor yet beside the rill,
 Nor up the lawn, nor at the wood was he;

'The next with dirges due in sad array
 Slow through the church-way path we saw him
 borne.
 Approach and read (for thou canst read) the lay
 Graved on the stone beneath yon aged thorn.'

THE EPITAPH.

*Here rests his head upon the lap of Earth
 A Youth to Fortune and to Fame unknown.
 Fair Science frown'd not on his humble birth,
 And Melancholy mark'd him for her own.*

*Large was his bounty, and his soul sincere,
 Heav'n did a recompense as largely send:
 He gave to Mis'ry all he had, a tear,
 He gain'd from Heav'n ('twas all he wish'd) a
 friend.*

*No farther seek his merits to disclose,
 Or draw his frailties from their dread abode,
 (There they alike in trembling hope repose,)
 The bosom of his Father and his God.*

Dover Beach
Matthew Arnold, 1822-1888.

The sea is calm tonight.
 The tide is full, the moon lies fair
 Upon the straits; on the French coast the light
 Gleams and is gone; the cliffs of England stand,
 Glimmering and vast, out in the tranquil bay.
 Come to the window, sweet is the night-air!
 Only, from the long line of spray
 Where the sea meets the moon-blanch'd land,
 Listen! you hear the grating roar
 Of pebbles which the waves draw back, and fling,
 At their return, up the high strand,
 Begin, and cease, and then again begin,
 With tremulous cadence slow, and bring
 The eternal note of sadness in.

Sophocles long ago
 Heard it on the Aegean, and it brought
 Into his mind the turbid ebb and flow
 Of human misery; we
 Find also in the sound a thought,
 Hearing it by this distant northern sea.

The Sea of Faith
 Was once, too, at the full, and round earth's shore
 Lay like the folds of a bright girdle furled.
 But now I only hear
 Its melancholy, long, withdrawing roar,
 Retreating, to the breath
 Of the night-wind, down the vast edges drear
 And naked shingles of the world.

Ah, love, let us be true
 To one another! for the world, which seems
 To lie before us like a land of dreams,
 So various, so beautiful, so new,
 Hath really neither joy, nor love, nor light,
 Nor certitude, nor peace, nor help for pain;
 And we are here as on a darkling plain
 Swept with confused alarms of struggle and flight,
 Where ignorant armies clash by night.

The Lake Isle of Innisfree
William Butler Yeats. 1865–1939

I will arise and go now, and go to Innisfree,
 And a small cabin build there, of clay and wattles
 made;
 Nine bean rows will I have there, a hive for the
 honey bee,
 And live alone in the bee-loud glade.

And I shall have some peace there, for peace comes
 dropping slow,
 Dropping from the veils of the morning to where the
 cricket sings;
 There midnight's all a glimmer, and noon a purple
 glow,
 And evening full of the linnet's wings.

I will arise and go now, for always night and day
 I hear lake water lapping with low sounds by the
 shore;
 While I stand on the roadway, or on the pavements
 gray,
 I hear it in the deep heart's core.

To Autumn
John Keats (1795–1821)

Season of mists and mellow fruitfulness,
 Close bosom-friend of the maturing sun;
 Conspiring with him how to load and bless
 With fruit the vines that round the thatch-eves run;
 To bend with apples the moss'd cottage-trees,
 And fill all fruit with ripeness to the core;
 To swell the gourd, and plump the hazel shells
 With a sweet kernel; to set budding more,
 And still more, later flowers for the bees,
 Until they think warm days will never cease,
 For Summer has o'er-brimm'd their clammy cells.

Who hath not seen thee oft amid thy store?
 Sometimes whoever seeks abroad may find
 Thee sitting careless on a granary floor,
 Thy hair soft-lifted by the winnowing wind;
 Or on a half-reap'd furrow sound asleep,
 Drows'd with the fume of poppies, while thy hook
 Spares the next swath and all its twined flowers:
 And sometimes like a gleaner thou dost keep
 Steady thy laden head across a brook;
 Or by a cyder-press, with patient look,
 Thou watchest the last oozy hours by hours.

Where are the songs of Spring? Ay, where are they?
 Think not of them, thou hast thy music too,—
 While barred clouds bloom the soft-dying day,
 And touch the stubble plains with rosy hue;
 Then in a wailful choir the small gnats mourn
 Among the river shallows, borne aloft
 Or sinking as the light wind lives or dies;
 And full-grown lambs loud bleat from hilly bourn;
 Hedge-crickets sing; and now with treble soft
 The red-breast whistles from a garden-croft;
 And gathering swallows twitter in the skies.

Aftermath
John Updike

When the summer fields are mown,
 When the birds are fledged and flown,
 And the dry leaves strew the path;
 With the falling of the snow,
 With the cawing of the crow,
 Once again the fields we move
 And gather in the aftermath.

Not the sweet, new grass with flowers
 Is this harvesting of ours;
 Not the upland clover bloom'
 But the rowen mixed with weeds,
 Tangled tufts from marsh and meads,
 Where the poppy drops its seeds
 In the silence and the gloom.

We'll Go No More A-Roving
George Gordon Byron, Lord Byron. 1788–1824

So, we'll go no more a-roving
 So late into the night,
 Though the heart be still as loving,
 And the moon be still as bright.

For the sword outwears its sheath,
 And the soul wears out the breast,
 And the heart must pause to breathe,
 And love itself have rest.

Though the night was made for loving,
 And the day returns too soon,
 Yet we'll go no more a-roving
 By the light of the moon.

Sea-Fever
John Masefield (1878-1967)

I must down to the seas again, to the lonely sea and the sky,
 And all I ask is a tall ship and a star to steer her by,
 And the wheel's kick and the wind's song and the white sail's shaking,
 And a grey mist on the sea's face, and a grey dawn breaking.

I must down to the seas again, for the call of the running tide
 Is a wild call and a clear call that may not be denied;
 And all I ask is a windy day with the white clouds flying,
 And the flung spray and the blown spume, and the sea-gulls crying.

I must down to the seas again, to the vagrant gypsy life,
 To the gull's way and the whale's way where the wind's like a whetted knife;
 And all I ask is a merry yarn from a laughing fellow-rover
 And quiet sleep and a sweet dream when the long trick's over.

Joseph V. Smith
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