

WILLARD C. LACY
(HM, AEG; FGSA; b. 1916):
Founder of
Geological Engineering
at The University of Arizona

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by

Allen W. Hatheway, HM, AEG
Professor of Geological Engineering, Retired
Department of Geological Sciences & Engineering
University of Missouri-Rolla
Rolla, Missouri 65407-0230

Lothar M. Klingmuller
Economic Geologist, Retired
Lakewood, Colorado 80226

ABSTRACT



Willard C. Lacy, already a prominent metals-ore economic geologist, founded a program in Geological Engineering at the University of Arizona in 1964 and applied to that highly successful venture some outstanding facets of teaching and research. Lacy's graduates fanned out into all of the areas of application of geological engineering and made considerable presence in those fields, including leadership in teaching and in the two professional associations sponsoring this journal. The life and career of Willard Lacy is a celebration of the discovery, perfection and application of the principles that underpin the potential

of this difficult major and profession, combining the elements of classical geology with engineering application.

Lacy can be remembered as the one individual, in North America, who created a concentrated teaching and technical-ideological home for Engineering Geology, through the medium of Geological Engineering. Lacy left the “basics” to Arizona’s Geology and Civil Engineering Departments and concentrated his efforts, and those of his faculty, on creating practitioners with the ability to apply classic scientific knowledge and engineering principles to solution of problems that stand in the way of achieving optimal goals in the minerals exploration/mining and engineered construction industries. Lacy not only was a man of his times, but one who sensed a need and then moved to fill that void. His legacy lives not only through the achievements of his graduates, many of whom are now passing into retirement, but of their replacements who may have benefited from the intrinsics and the derivatives of his teachings.

1.0 RELEVANT CONTRIBUTIONS of WILLARD C. LACY

The point of this biography is to memorialize a significant time-and place movement within the greater profession of Engineering Geology, in which Geological Engineering was given a new face in a new program of academic instruction, that of the School of Mines of the University of Arizona. “Bill” Lacy moved to found this program in 1964, at the invitation of incoming Dean of Mines, J.D. Forester, at a point when Lacy had been in the practice of applied geology for 28 years. Lacy got the program up and running a year later and brought new focus to a field that had been recognized for 51 years (since 1913). The timing of Lacy’s efforts seemed perfect.

1.1 TIME had come for a RESURGENCE of GEOLOGICAL ENGINEERING

The historical background for geological engineering as a sub discipline of applied geology is complex and not well known to most members of the profession. Geology as a profession stemmed from the observations, deliberations, application and writings of William Smith, a civil engineer who designed and constructed canals and early railroads in Great Britain. The minimal topographic relief of the English midlands gave rise to Smith’s ideas of moving commerce about the heart of British coalfields and iron industry required construction of frequent cuts in order to maintain optimal

hydraulic flow gradients. Smith's observations and works spanned 1820-1850 and were carried further forward in 1880 by W.H. Penning in the first technical book to be entitled *Engineering Geology*, a work that set the stage for application of geologic principles to economics, mainly those involving engineered works and the recovery of drinking water.

1.2 ENGINEERING GEOLOGY in NORTH AMERICA

While Penning's 1880 book was being received in the English-speaking world, the American founder, William O. Crosby, had appeared as a student, graduate and faculty instructor at the fledgling Massachusetts Institute of Technology (MIT), then a state college founded under the provisions of the Federal Morrill Act of 1863. Crosby graduated in 1876, and was well received in engineering circles of Boston, which, along with New York City, was a center of design and construction engineering for civil works. At that time, military construction had been under the direction and control of U.S. Army engineers, graduates of the Military Academy at West Point, New York, since 1802. Through 1964, all West Point graduates were trained as engineers, and were instructed to appreciate terrain and geologic factors.

Thus, with the appearance of Professor Crosby in the Boston center of engineered construction, engineering geology was on an up-ramp in North America. Meanwhile, in New York City, Columbia College (formerly Kings College, and later Columbia University) had instituted a School of Mines (1874). Out of this association rose Charles Peter Berkey, who also was appointed to the Columbia geology faculty and who, for years, was the full-time, paid Secretary of The Geological Society of America, then also headquartered in New York City. By 1900, Berkey was the favorite geological consultant to the New York City civil engineering profession, and he enjoyed the same degree of prominence as was the situation for Professor Crosby, at Boston.

1.3 ENGINEERING GEOLOGY as a RECOGNIZED DISCIPLINE

Largely due to the examples set by Crosby and Berkey, west coast civil engineers began to pay attention to the now-obvious need for geologic input to their projects. It appears that most of this impetus came from the frequent inclusion of geologic topics in the *Transactions* and *Proceedings* of the American Society of Civil

Engineering (ASCE) and the fact that a few civil engineering graduates of the University of California (Berkeley) were appearing in practice. Notable among these was Maj. Edwin C. Eckel who held dual degrees and was prominent in national practice of engineering geology from that time well into the 1940s.

When American Federally-sponsored civil construction programs burst on the scene with the New Deal (1934), engineering geologists were being added to the regular line structure of the Corps of Engineers, the Bureau of Reclamation, the Soil Conservation Service, and the Tennessee Valley Authority (TVA). Major Eckel, a combat divisional geological staff officer, veteran of the WWI American Expeditionary Force (AEF) in France, was named as the first Chief Geologist of the TVA. Major Eckel is believed to have been the first chief geologist of a U.S. Federal agency.

With the advent of World War II, many of the Federal geologists who had been hired into the agencies since 1934, volunteered or were drafted into the U.S. Army and some were recognized for their talents in the subfield of Military Geology. Included here were Major Eckel's son, Edwin B. Eckel, who became the post-WWII founder of the now regrettably-defunct Branch of Engineering Geology.

Of course, while the American Federal Government was "waking up" to engineering geology, Karl Terzaghi, at Harvard University, in 1933 had permanently returned to the United States from Germany after his 1925 visit. Harvard, in those days, was temperate toward teaching and research in applied science and in practical engineering, and Terzaghi not only launched and propelled "soil mechanics" onto the world scene, but incidentally brought forth the notion of "rock mechanics." By the 1940s Terzaghi had incorporated second-wife, geologist Ruth into the Terzaghi team.

1.4 ESTABLISHMENT of GEOLOGICAL ENGINEERING

In 1913, the Colorado School of Mines (CSM), always mindful of teaching and preparing geologists for service in the direct application of the science, created the discipline of Geological Engineering, the first such program worldwide. As has been the universal case for the profession in North America, the earliest financial support for Geological Engineering came from the minerals industry and CSM made the most of that appreciation. This simple fact has been underrated in our appreciation

of the times and fate of geological engineering and it cannot now be disregarded in times of institutional stress for the discipline. Mining and petroleum companies early became impressed with the utility of geological engineers in the development and operation of mines and oil and gas fields, and their financial support has remained crucial to the health of geological engineering academic departments.

1.5 FLOURISHING of GEOLOGICAL ENGINEERING

Willard Lacy's program of Geological Engineering was approved and came into being at the School of Mines in Tucson late in the Fall of 1964. Lacy correctly sensed that the time for creation of the Arizona program was at hand and he moved boldly in that direction. As a base, he chose to move from the Geology Department at the University of Arizona, to the Mining Engineering Department, which was suffering from a sag in leadership and direction. A combined Department of Mining & Geological Engineering was thus created. Lacy had strong ties of practice with the copper mining industry and he left the Geology Department with its modest ties to the petroleum industry to capitalize on his perceived need for geological engineers in the metals mining industry and in civil construction.* (Editor: N.B. Footnote below)

1.6 DEMISE of GEOLOGICAL ENGINEERING

In contrast, the civil engineering and construction professions have contributed financially to North American geological engineering programs to only a minor degree. The end product of that disregard now is sadly extended by the long-term withdrawal of the American mining and petroleum industries from their support of the professions. Consequently, preparation of geological engineers has been receding since about 1995, perhaps more rapidly in the United States than in Canada.

2.0 LACY'S EARLY YEARS in CHINA

For we outsiders to the developing human equation that has been Bill Lacy, his beginnings are couched in the now-forgotten life situations of Christian (Methodist in this case) missionaries in the China of the tumultuous pre-World War I years. Our subject was home-delivered by the local physician, a Dr. Buck, at the grandparents' 200-acre family fruit property, W.G. Farnsworth Orchards, in Waterville, Ohio, 17 July, 1916. His parents, William Irving Lacy and mother, Grace Farnsworth

Lacy, were on furlough from their China mission. At less than a year's age, our subject was in China where William and Grace had returned to the superintendency of Methodist schools in southern China. Home is remembered by Bill as "a very nice house in a walled compound, at Yenping, Foochow Province (**Fig. 1**).

Bill's first schooling was provided by his mother and in accordance with the Calvert System, the home teaching system favored by missionaries and other Americans living in remote areas of the world. Grace taught not only Bill and his brother, but also the neighbor children.

Footnote:

* The timing also was right for the senior author who had just left active service in the U.S. Army (1963) and moved to Tucson with the expectation of taking a Master's program in geology. Furthermore, as the situation developed that neither the geology nor new hydrology programs were appealing the senior author became the first geological engineering student of Lacy's new graduate-level program.

The family had been in China so long as to have build a summer time family retreat not far away, at Koolian, high enough in the surrounding hills to offer respite to southern China's summer climate. Lacy's parents came to their calling through paternal grandfather, Dr. William H. Lacy, who was then head of the Methodist Publishing House and the American Bible Society. With his grandparents having served in China since 1887, his father's four siblings were also career missionaries in China. All of these forebears of Bill's were graduates of Ohio Wesleyan University.

Bill returned to the United States until the age of six. Back at Waterville, he was enrolled in a public school located near the abandoned Erie Canal. Bill's first case of geologic exposure came from swimming in the cold and clear water of an abandoned limestone quarry, when not working the orchards and having the thrill of driving an "ancient" White Truck down its leafy lanes.

Bill's father took work with the Cleveland, Ohio, Humane Society, then oriented toward needy people rather than stray animals. Bill learned more of life here in

Cleveland suburb of Lakewood, including having to battle bullies who would tend to pick on his younger brother Bud, whose right arm had been withered by polio. Bill himself suffered a light case of polio and had no after-effects, but did have to overcome the obstacle of speech stammering. More of life's lessons were learned during the depression, as the family was not economically immune from those character-building opportunities. In 1929, the family moved to Aurora, Ohio, then a small country town with a school enrollment of 300. Bill, weighing less than 100 pounds was pressed into many athletic programs. He remembers, in a football game with their arch rivals, he was penalized for "unnecessary roughness." He did well in high school track competition (Fig. 2).

3.0 FORMAL EDUCATION

The Lacys were people who regarded higher education as a natural goal and they carefully prepared Bill to take full advantage of all learning opportunities.

3.1 Willard C. Lacy, Chemist (DePauw University, 1934-1938)

On the basis of an outstanding High School record (except for Latin), Bill was granted a Rector Scholarship at DePauw University, a Methodist college in Greencastle, Indiana. He pledged Phi Gamma Delta ("Fiji") social fraternity, earned his meals as a waiter at Alpha Chi Omega sorority, and "lettered" four years in track - running cross-country, the 220, 440, and mile relay. He majored in chemistry - with a remarkable group of 13 majors in the senior class, all of whom went on to graduate school and earned Ph.Ds (Fig. 3).

Completing his undergraduate program as a chemistry major, Bill was grandly affected by Professor "Rock" Smith, remembered by Bill as an intriguing eccentric and the erstwhile junior chemist took enough of those courses to realign his graduate-school goal to geology.

3.2 Bill at Iowa State University's Deadwood Field Camp (1938)

Bill's next academic stop was the University of Illinois, on the

recommendation of De Pauw's Professor Smith. On reflection of DePauw's limited field geologic mapping experiences, Bill signed up for the 1936 University of Iowa geology summer field camp at Deadwood, South Dakota.

3.3 Bill's MSc In Geology - University of Illinois (1938-1940)

With the Iowa State field experience under his belt, Bill then enrolled at the University of Illinois at Champaign-Urbana, where he capitalized on his chemistry background to serve as graduate teaching assistant in mineralogy to Professor Carleton Chapman. During his two-year stint at Illinois, Bill not only qualified to be a geologist, but also met future wife Jo, a physical education major from Harvey, Illinois, then a small industrial town 17 miles due south of Chicago. With a year of junior college and money earned clerking for Montgomery Ward, Jo competed for a New Deal NYA (National Youth Authority) part-time job at Illinois and was assigned as a student assistant to the Geology Department, coincidental with the arrival of Bill Lacy. Both left the University of Illinois with new degrees and married in 1940, on the way to Cambridge, Massachusetts.

3.4 Bill at Harvard University (1940-1942)

Professor Chapman, himself a Harvard doctoral product, was instrumental in gaining graduate admission for Bill at Cambridge in 1940, with a pre-aligned areal mapping dissertation project in Ontario Province (**Fig. 4**). The remote area, accessible only by canoe, was an idyllic environment for Bill's adventurous spirit, and he later convinced his father to purchase land near Perry Sound that was thereafter used as a family summer retreat.

Jo and Bill were married in August 1940 (**Fig. 5**) in a small Presbyterian church at Sunridge, Ontario, an event complicated by World War II already raging in Europe and in Bill's words: "that the facts that we were Americans being married in Canada, and that Jo's father was born in Germany, her mother in Lithuania and that my father was born in China - and we didn't have much money!"

While at Harvard, Bill and Jo lived in a tiny two-room apartment and subsisted on “cod cheeks and tongues” as the cheapest meat substitute available at the time, and cooked on a two-burner gas grill piped to a closet. In the Geology Department, Bill served as petrography laboratory assistant to Dr. Esper (“Ep”) Larsen. Jo got work with the Harvard *Crimson* campus newspaper and later as a novice teletype operator, then secretary, then administrative assistant at the Boston Ordnance District office of the War (Army) Department.

4.0 BRIEF PRE-WORLD WAR II MINERAL EXPLORATION (1942-1943)

Plagued with gasoline rationing and long mileage to and from his field area in Canada, Bill took leave from his doctoral program and joined the Titanium Alloy Manufacturing Company as an exploration geologist. He quickly was turned to the field to search for critical war materials such as rutile, zircon and tantalum. It was on this quest that Bill made his first mineral discovery of a rutile and zircon placer near Jacksonville Beach, Florida. This “blood, sweat and tears” strike came from post-hole digger sampling. Bill developed the deposit through extensive sampling gravity separation by Humphrey spirals, to produce a heavy concentrate, which was then separated (in his motel room) to magnetic and electrostatic fractions by night-time binocular microscope examination. The result indicated a valuable mineral deposit and he was pleased when the project went forward and when mined-out, was regraded and turned into prime real estate.

With the successful discovery and development planning out of the way in Florida, Bill and Jo were moved to Lewiston, NY, outside Niagara Falls, from which he was sent to evaluate pegmatites containing tantalum and lithium, in the Black Hills of South Dakota. On completion he was sent to a prospect area at Magnet Cove, Arkansas, where he discovered and mapped a rutile deposit within a diatreme structure.

5.0 SERVICE DURING WORLD WAR II (1943-1946)

In 1943, Bill’s Selective Service number was drawn and he was allowed to

volunteer for the Navy, heeding a Naval Intelligence call for individuals with the ability to interpret aerial photographs for prediction of amphibious landing conditions. After being sworn in, induction testing brought forth an offer of a direct commission, but the “bad” news was that the photointerpretation billets were filled and that he had been assigned to Aviation Ordnance as an Ensign. With several months of orchestrated delay before reporting for “Officer Basic,” Bill and Jo and first-child John (now a mining attorney in Tucson) were allowed to return to Lakewood, Ohio, where Bill worked as a night-shift inspector of EverReady batteries, and was then employed as a “grease monkey” at an auto lubrication garage.

Orders for duty also arrived in 1943, for Fort Schuyler, New York. On graduation from officer training, Ensign Lacy was assigned to the Naval Aviation Ordnance School, Jacksonville Naval Air Station, Florida (**Fig. 6**), not too far from his earlier rutil strike. Now Bill was traveling, making inventories of naval ordnance at various air stations, while Jo and now two children (John and Carol) remained at Jacksonville.

On completion of the ordnance inventory, late in 1944, Bill was assigned to the Naval Aviation Supply Depot, Oakland, California, and his father loaned enough for purchase of a small house near the Oak Knoll Naval Hospital. Bill was placed in command of the Assembly and Repair Facility and, in addition to official ordnance repair, installation and modification, Bill’s shop included a sailor who was formerly an expert auto repair bodyman. This shop capacity led to returns of fender-straightening and dent-removal favors from the Station Admiral right on down the chain of command.

6.0 EARLY CAREER in the PERUVIAN COPPER MINES (1946-1955)

With the end of World War II, Naval Lieutenant Lacy was informed that discharge from Active Duty was imminent in 1946 (**Fig. 7**). Bill shot off a letter off to Dr. L.C. Graton at Harvard, a favored consultant to Cerro de Pasco Copper Company in Peru. The connection worked and Bill was offered a full-time position in Peru and the

family of four headed their 1930 Model A Ford from California back to Company headquarters, at 40 Wall Street, New York City.

The Lacys were assigned to the company smelter town of La Oroya, situated in the Andes at an elevation of 12,300 feet. In those days, the trip from Lima to the smelter took days, mostly for acclimatization, considering that the 16,300-foot Ticlio mountain pass had to be surmounted on the journey.

Company-furnished quarters were modern and spacious and included all furnishings, utilities, maintenance and firewood for fireplaces, all this for \$15 a month and included a bankside location on the Mantaro River. While in Peru, Bill notes that the extreme altitude did not hamper enlargement of the family, as four more children were born to the Lacys before their departure in 1955.

Bill's nine years with Cerro began as petrologist, in a laboratory for which he was the first person in charge and therefore was able to specify all that he wished to have. Much of his work time was spent in making the rounds of the various company mines and prospects, in sampling and collecting ore and hand specimens. At its height of activity Cerro had seven operating metal mines, two coal mines, and a dozen developing prospects, and all in a land of few roads and steep, rugged terrain. One of the operating mines had its portal at nearly 18,000 feet of elevation, at Laguna de Santa Anna, the true headwaters of the Amazon River. Due to the need to make photographic records, Bill's skill as a budding photographer resulted in his becoming the camp photographer.

Photography was used to document the petrographic analyses, and this skill also served the engineering geologic studies well, with company needs as hydroelectric power and retaining dams. Bill recalls fondly the hydroelectric scheme sited and designed for the Paucartambo River, another eastern-slope tributary to the Rio Amazonia, selected for construction at elevation 5,000 feet and flanked by mountains rising to more than 15,000 feet of elevation – a two-mile deep gorge, twice the depth of the Grand Canyon. The diversion tunnel required detailed geologic mapping along its alignment.

During his early Harvard years, Bill had been impressed by Karl Terzaghi's true geological engineer teaching civil engineering at Harvard. Later Bill was fond of telling his own Arizona geological engineering students of the many pearls of wisdom he had learned from him whom we had come to call "The Great Man." More exposure to engineering geology came Bill's way after his appointment as Assistant Chief Geologist, assignments like ten-day horseback trips over potential haul routes identified by his own aerial photointerpretation (Fig. 7).

7.0 COMPLETION of the DOCTORATE (1952)

The fact that Cerro de Pasco hired its professional staff on renewable three-year contracts left Bill with an opportunity to make use of a between-contracts, six-month leave of absence in 1949, to return to Harvard for more work toward completion of his graduate studies. On his return to Peru, in 1950, Bill was appointed Assistant Chief Geologist. The connection remained ideal for Bill when he left to teach at Arizona, having summer appointments in Peru as a consultant to Cerro. Harvard ties were also kept and Bill returned to Harvard in 1952 for six months at the end of his second three-year contract, as a sabbatical replacement for ore deposits Professor Hugh McKinstry, himself on university sabbatical leave (Of course, sabbatical leaves are now mostly a thing of the past in North American universities). Fortunately for Bill, the second of his leaves provided the time necessary to complete and defend his dissertation based on his Cerro experiences. Shortly after his return he was named Chief Geologist.

8.0 TEACHING at the UNIVERSITY of ARIZONA (1955-1971)

It can be imagined that having been raised in a changing alien world, Bill was not prone to dwell on existing situations, but always alert to assess his surroundings and how to adapt most efficiently, if not optimally. Carrying this forward, his life, times, and methods become apparent.

This turn in the Lacy career was driven mainly by the perceived need to return to the States in order to see the elder children through to a more proper education without splitting up the family. Eldest child, John, was then ready to enter high school. For this purpose Bill again asked support of L.C. Graton and received faculty

appointment offers both from the University of Texas (Austin) and the University of Arizona. Arizona's offer was the better in terms, with only a fifty percent cut from his salary at Cerro and appointment as a Full Professor, with tenure.

8.1 Combining Teaching and Academic Development (1955-1963)

At Tucson, in June of 1955 Bill Lacy stepped directly into the shoes of the legendary Professor, Bert Sylvenus Butler and also those of the deceased Prof. Max Short, whom Bill remembers as a general all-around mineral technologist. Dr. Fritz Galbraith was Head* (not Chairman!) of Geology and Bill was given the task of revitalizing Arizona's long-standing economic geology program. Bill retained his consulting contacts with Cerro de Pasco, and continually had access to real-world case histories for class work, topics for theses and dissertations and fulfilling the informal obligation (of that time) of placing good graduates in good professional career positions.

8.2 In Trouble for Telling the Truth (1960)

Here we weave in the energetically pleasant and hard-driving Edgar McCullough, then a Lacy geology student, and later the creative head of Arizona's Geology Department and Dean of Arts & Sciences. Bill directed Ed's Ph.D. dissertation mapping of the rugged western flanks of the Catalina Mountains, the toe of which forms the northern boundary of Tucson. Ed had discovered a major NW-trending fault of considerable geomorphic presence, along that base of the range and coincidentally the local landform presented attractive land development potential.

It turned out that a Tucson land developer had a recreational lake and marina project in mind and in 1960 was constructing an earth-fill dam for that purpose.

Footnote

A note is important here, in that "Heads" govern by authority and "Chairmen" govern by consensus; Department Heads now have largely disappeared in the U.S. As Bill was flying out of Tucson heading for the AIME meeting in New York City his seat-mate turned out to be all ears to Bill's views that the dam was already leaking, due to the porosity of its own alluvial foundation materials. The banker turned out to be

financing the operation and deplaned at the first stop, to phone-cancel the loan to Golder. On his return from New York, Lacy had a message from the developer's lawyer with news of a million dollar law suit. Fortunately, the next day, the same firm requested Bill to serve as remedial consultant. Bill declined and recommended George Kiersch. Bill reported that "In spite of all efforts the dam continued to leak at a dangerous rate and the State required a slot to be cut through the dam - no lake, no marina, no lawsuit."

8.3 Geology Department Gets its Own Mine (1962)

Just south of Tucson lie the Twin Buttes, known to have copper values. Bill had a program of detailed surface mapping going on with his students, with underground mapping at the abandoned Eagle-Pitcher Twin Buttes Mine. Anaconda came in and bought the property in 1962 and declared the old mine excess to its property development plan. Bill was then successful in having the mine conveyed to the University as a teaching facility.

9.0 CREATION of GEOLOGICAL ENGINEERING at ARIZONA (1963-1964)

Our assessment of Bill Lacy is that he early was inured to the concept of being involved in some sort of service to others. In 1963, when Dean Forester asked Bill to establish and head a Department of Mining and Geological Engineering, the challenge involved:

- 1) defining requirements for both Mining Engineering and Geological Engineering;
- 2) having the programs accepted and accredited by the Engineers' Council for Professional Development (ECPD), and;
- 3) recruiting students into both programs.

Naturally, the notion of competing for geological engineering students, at the new department was not popular with the Geology Department.

At the creation, the Mining Engineering's faculty had attritted to but two faculty members, Professors Harry Krumlauf and Jay Dotson. Lacy, the third faculty member of the new department, was the only geologist. In a short time, however, Dean Forrester

had approved the addition of Dr. Bill Peters, recruited from the Bingham Pit in Utah, and a bit later Dr. John Sumner, a mining geophysicist on the Phelps Dodge staff at Bisbee. Sumner's appointment was in the Geology Department, but he was a key figure in the geological engineering program as well. Dr. Erich Sarapu was Visiting Professor, teaching rock mechanics and unconventional mining systems, and stayed on until arrival of newly-minted, tenure-track Assistant Professor John F. Able. Marge Fowler, married to a retired Air Force officer, served as the initial secretary and maintained contact with the departmental alumni, who were all mining engineering alumni, and put out a department newsletter.

The bottom line was that Dean Forrester hatched the idea, but his willing and receptive lieutenant, Bill Lacy, made it all happen. Without this one person, the new Geological Engineering would never have happened.

9.1 LACY the PRAGMATIST

To his biographers, Bill is regarded as the ultimate pragmatist, and most of us learned, out of respect and admiration, to adopt this philosophy. That is, don't be deterred from reaching a first-order approximation of the solution, for fear of not having sufficient data or length of observation required for a more comfortable solution to the problem at hand. Most of our problems involved the identification and assessment of geologic "constraints" (a term we borrow from the works of Dr. Robert F. Legget, of Canada) and their arrangement in terms of engineering parameters and engineering conclusions and recommendations. This Lacy mindset provided simple overall guidance toward a productive work product, achieved in meaningful time and delivered in terms and language familiar to the client.

9.2 DEFINING GEOLOGICAL ENGINEERING

A real necessity of the times, was that Geological Engineering be defined as an engineering discipline. Although the discipline had been created at the Colorado School of Mines some 60 years before, there had never been a pathway for professional registration as engineers. Lacy rightfully presumed that to sell the product and be true to the degree holders, graduates had to be licensable as geological engineers, rather than the then-traditional route through the civil engineering professional registration.

Accordingly, Lacy went into action through his long-standing membership in AIME (American Institute of Mining Engineers) and became active in their meetings: presenting papers, presiding at sessions, and becoming active in various committees. By way of this activity he was appointed to the Education Committee, then as their ECPD (Engineers Council for Professional Development; a joint effort of all of the engineering societies) representative. Lacy then wrote the definition and academic requirements for Mining Engineering and Geological Engineering -- interfacing with the constructed environment represented by Civil Engineering. His Harvard association with Dr. Karl Terzaghi, the internationally founding father of "soil mechanics" and "rock mechanics" provided the insights necessary for defining the requirements. As a member of the ECPD accrediting team, Lacy could then encourage compliance and both "Engineering Geology" and "Geological Engineering" took form and acceptance.

It was necessary to create an employment market for graduates and Lacy moved quickly to sell the program to industry. This was facilitated through consulting opportunities and served to gain exposure both for geological engineers and mining engineers at the same time, through seminars and symposia that attracted mine managers and executives world-wide. In 1965 digital computation was just breaking ground and Lacy moved first to sponsor a symposium, "Application of Computers in the Mining Industry," attracting prominent engineers from all over the world.

Lacy's upstart activity became very unpopular at the Colorado School of Mines (CSM) when Lacy, in the capacity of a member of their visiting accreditation team, recommended certain of his visionary changes be made in the CSM curriculum or that it should suffer the loss of its accreditation. CSM had been the defacto model for preparation of both mining and geological engineering, but they had slipped and were being judged as not meeting the current needs for undergraduate preparation for both disciplines.

In order to generate undergraduate student enrollment, Lacy joined and became active in the International Society of Engineering Educators (ISEE), the International Society for Rock Mechanics (ISRM), and the American Society for Testing & Materials

(ASTM) and used those pulpits to promote the Arizona program. He also initiated “Career Day” visitations to high schools in Tucson and Phoenix. Bill’s effort was both tempered and helped by Jo’s activities as career counselor at Tucson’s Rincon High School. In addition, Marge Fowler began sending out a newsletter to all alumni of the College of Mines, bringing them up-to-date with the new joint program and its activities and soliciting their support for a work/study program and employment opportunities. The effort was successful and undergraduate enrollments sky-rocketed.

9.3 LACY the RECRUITER

In September 1964, Bill was formally appointed as the first Head* of Mining and Geological Engineering and he was poised to secure the three ingredients essential to sustain his vision of modern geological engineering as an academic discipline at Arizona: 1) Faculty; 2) Students; and 3) off campus financial support. In 1962, Bill made his annual trek to the AIME meetings in St. Louis; then early in June he went to Lexington, KY to the ISEE; in September he presented a paper at the Mining Congress in Seattle. Typical of Lacy attention to his graduate student’s field mapping, he recruited son John to join him in a late July and early August road circuit of 5000 miles, across AZ, NM, CO, WY, ID, UT, NV, OR and CA, reviewing graduate student field results.

9.3.1 Students

Naturally, Dean Forrester’s notion became Lacy’s enthusiastic calling, but one of the essential ingredients was students. A few mining engineering undergraduates were already in place, from the old Mining Engineering Department. Lacy’s first Departmental graduate student was James Sherman, a Michigan Tech BS Mining Engineer and senior author Hatheway was an unannounced candidate for Geological Engineering. Hatheway “dropped through the skylight,” so to speak, having just left active duty with the U.S. Army, as an officer Aerial Observer with the 4th Infantry Division at Fort Lewis, Washington. Totally outside of the Lacy perimeter, Hatheway, an AB Geology graduate (1961) of UCLA, had gained a desire to attend Arizona from his UCLA graduate igneous and metamorphic petrology lab mate, MS candidate Arthur Sylvester, later a California (Santa Barbara) professor. UCLA’s

Professor William C. Putnam seconded the choice and Hatheway appeared in Lacy's office, after being turned off by Geology's lack of offerings in Engineering Geology and by John Harshbarger's indifference with respect to his participation in the new Arizona program in Hydrology.

Jim Sherman took Hatheway under wing and found employment for the newcomer, with the local office of the U.S. Bureau of Mines. That was August of 1963. Sherman completed the MS and went on to enjoy a good local career in teaching mathematics at Pima County Junior College (Tucson) and publishing several books on historic western mining towns, with wife Barbara.

Bill Lacy's frantic activity in announcing the presence of the new program resulted in several more graduate students arriving in 1964 and more in 1965. Unlike Hatheway, these candidates already possessed undergraduate degrees in mining or geological engineering. Lacy had struck pay-dirt in making his rounds and the new batch came mainly from Colorado Mines, with other representation from the University of Minnesota, Purdue and Case Western Reserve. Of the first batch of graduate students, Hatheway the only intrepid geologist of the group, trying to become an engineer, as a new graduate student. In 1966, Professor Dotson made a connection for Hatheway, based on the latter's just-completed MS thesis. Dr. Gerard P. Kuiper, the eminent planetary astronomer, and director of the University's Lunar & Planetary Laboratory (LPL) had made a generic comparison of the block-caving subsidence at San Manuel Copper Mine to his hotly contested belief that the lunar mare were actually lava fields. Kuiper's earth analogy were lava tubes. Shortly, Hatheway's mining subsidence research turned into doctoral support on defining the nature and parameters of lava tubes and collapse depressions, funded by NASA, through co-direction of Lacy and Kuiper.

Hatheway and Christopher C. Mathewson, both passed their doctoral defenses on the same day in May, 1971, after both had been away from Tucson, in ABD (all but dissertation) practice. Mathewson was a later grad-school arrival and one of a few with a straight civil engineering background. Both have served as AEG Presidents (Hatheway in 1985 and Mathewson in 1989), with Mathewson also serving as

Association Executive Director (1998-2002) and *Bulletin* Editor (1981 - 1986). Both men also carried Lacy-Think forward as Chairmen of the GSA Engineering Geology Division (1980 and 1987).

Among the notable Arizona Geological Engineering undergraduate students is AEG Past President and GSA Engineering Geology Division Past-Chairman, Jeffrey Keaton, of the Class of 1971, who was EGD Chairman in 1990 and who served as AEG President in 1992.

9.3.2 Foreign Students

Another factor of optimal timing in creation of the new major and the expanded Department was that of South American nationalization of mineral resources, a process that had begun in Mexico about 1960, and had spread to Chile and Peru by 1964. Bill was known widely in South and Central American mining circles and could handle spoken and written Spanish. Unlike the situation of today, these foreign students arrived fully funded by their parent nations, as nationalization had both created the need for graduate training and the funds to support their American education. Lacy dived into this situation and developed a fine and capable body of a half-dozen mining and geological engineering graduate students at any given time, from 1965 to his departure in 1971. Most of the students had actual career experience and many were from influential families in those nations and had good work ethics and spoke and wrote good English.

9.3.3 Faculty

Geology at the University of Arizona was largely practical in orientation at the time that Lacy moved on Geological Engineering. That trend can be traced to the late Professor Ben S. Butler, who had joined the Arizona faculty about 1910, from a distinguished career in practice. Butler remains important to this date, not only for his pioneering work on ore deposits but for his role in establishing professional registration for geologists in the United States, This effort started in Arizona, in 1921,

the first such licensure in America, and followed nearly five decades later was continued by California, with both Geology and Engineering Geology recognized in 1969.

Even with Lacy's drive, his determination, capacity and competence would not have "carried the field" without his having convinced his long-time compatriot, William ("Bill") Peters to join him. Peters came down from Salt Lake City, where he had practiced as Chief Geologist for Utah Copper Corp., at the Bingham Pit. Bill, a WWII U.S. Army Signal Corps Captain, with combat experience in the European Theater, was the perfect partner in mineral exploration and mine development (Peters, 1978).

Next, Bill turned to John F. Abel, the iconoclastic and ultimately practical rock "mechanics" engineer, who joined the Department faculty in 1966. John had been in mining design and operation practice for 15 years and had just completed a late Ph.D. in rock mechanics at the University of Durham, Great Britain, and was induced to add this new field of practice (Abel, 1967) to the department offerings. Abel later left and finished his teaching career at the Colorado School of Mines.

From Canada, Bill sought Donald F. Coates, whom we still regard to have been the most practical rock engineer on the continent, of his time (Coates, 1965), to spend vacations in lecturing for us. Don, an avid tennis player, was additionally accommodated in that special "need" by Bill Lacy and we learned more about being audaciously practical. The reader may recall that the ultimate product of Don's works was the *Pit Slope Manual*, a massive 21-volume (Coates, 1977) commitment of the Canadian Government through the Canada Centre for Mineral and Energy Technology (CANMET) which Don directed at Ottawa.

Outside the department, Lacy's strongest teaching ally was Richard Lewis Sloane (Hatheway, 1975), Professor of Soil Mechanics (as it was then known). Bill kept a full stream of undergraduates and graduate students flowing through Sloane's tutelage, at least until the latter's untimely death at age 54, in 1974. Sloane had extensive experience in geotechnical practice and was just as practical in his teaching and research as was Bill. Dick further had great interest in clay mineralogy and had equipped and managed a fine micro materials laboratory for that purpose, in the Civil Engineering Department.

9.4 LACY on SEEKING INDUSTRY SUPPORT

Bill maintained a fundamental commitment to the fact that the minerals and heavy construction industry were the primary consumer beneficiaries of the fruits of his academic programs. This has always been a difficult playing field, more so with the construction entities and lesser with the mining industry. Neither industry had the cash-flow generosities (then, not now!) of the petroleum industry, but Lacy left that ground to the Arizona Geology Department and, amongst his university competition, to the Colorado School of Mines. Professor Jay Dotson underpinned Arizona mining industry support by creating and managing a series of evening courses for those in practice. These offerings also included seminars and consulting opportunities for the faculty and career-relevant part-time and summer jobs for students.

Of the construction-related corporate friends, the late firm of Dames & Moore, headquartered in Los Angeles, became the earliest and closest supporter of the Lacy programs. Money was not forthcoming, but personal involvement of such department friends as Gary Melickian and James Swaisgood were instrumental in creating substance to the desirability of Arizona Geological Engineers as employment candidates, and that rubbed off on students, as an aura of continuous possibility.

9.5 LACY as a TEACHER

Lacy was geared to organize and meet problems, head on. It was well known that he loved to teach the basic secrets for identifying and solving practical problems based on geologic properties, characteristics, situations and conditions. He never bothered a whole lot with detail, for he knew that there were too many details to learn or to teach and the secrets of success in applied geology was to develop a systematic approach to recognizing and dealing with geologic problems. Lacy's contributions to the profession are dominated by his truly giant accomplishments in teaching, but here he was able to reach an audience far beyond the classroom.

9.6 LACY'S OUTREACH

Bill always had the "big picture" in mind during his teaching, and

the goal here was simple; define the major impact and educate the maximum number of people to be receptive. Consistent with this drive were his efforts to codify and spread “the word.”

Consequently, one of the first major undertakings of the new Arizona Department of Mining & Geological Engineering was a contract with the U.S. Public Land Law Review Commission, to prepare a report on *Non-fuel Mineral Resources of the Public Lands* (published in 1969). Lacy served as associate principal investigator, along with George F. Leaming and the outline and content then served as a solid base for much of his teaching, and also to begin the formulation of the later TV documentary, *Out of the Fiery Furnace*. Bill brought to this review Dr. Ed Wisser, recently retired University of California (Berkeley) professor and veteran mineral explorationist of Mexico.

Once fired up with the successes of creating the new face of Geological Engineering, Lacy looked for new opportunities. He had the secret for motivating and producing undergraduate and graduate Geological Engineers and then became riveted on bringing “others” closer to recognition of what applied geology could do for them.

With son John in law school, Bill expanded his focus to include special non – litigation legal aspects of mineral extraction. He organized Symposia on *Public Land Law* (1966) and *Mineral Taxation* (1969) that contributed to the development of the *Special Litigation Model* for programs of the Rocky Mountain Mineral Law Foundation. John and Bill continued this liaison through their 1991 paper on the effect of mineral royalties on determination of ore-extraction cut-off grades. Bill continues to provide technical lectures to the mining law course of the University of Arizona Law School.

On the grand scale was his seven-part Australian television film production, *Out of the Fiery Furnace*, described a bit later in this paper, but which circled the globe, through the Public Broadcasting System (PBS; US) and the British Broadcasting System (BBS), in its contact with ordinary people who quest for knowledge.

10.0 “LACY THINK”

The Lacy that appeared before his students at the School of Mines at

Tucson was regarded as a helpful and pleasant taskmaster. In retrospect, Professor Lacy's technique of teaching was to seek competent and energetic students and then to develop considerable student interest in the taught materials and to offer the challenge that all of us were capable of seeking and achieving first-order, engineering-related solutions to applied geologic problems. Unlike some other programs, Lacy also injected a zeal for discovery and quantification of such problems, so that the Geological Engineer would emerge as an individual who could anticipate problems and then deliver appropriate solutions.

Here is how Lacy Think operated: Bill always required that his students generate bounds and numbers to be applied to all manner of problems. Not numbers for the sake of numbers, but to serve as an honest and forthright reference basis for all who make use of the geological engineering solution. Where the numbers did not exist, the rule was to go out and make relevant observations to quantify the situation. This quantification included all manner of measurements, or, when appropriate, estimates. But always the quantification was to be made with the qualification of their origin and of their relative degree of accuracy and reliability.

Lacy problems delivered to classes were never "whole" in scope and whether intended to be vague or not, the message was "don't whine; get down to brass tacks" and make the observations or estimates, but always be truthful to the point of declaring your assessment of their worth.

The first step was to work out the general parameters of the problem:

- 1) What was the client/owner objective?
- 2) Define the process that was to take place at the specified engineered works
- 3) What were the three-dimensional bounds of the project?
- 4) Compile or estimate the subsurface conditions influencing the geotechnical and hydrogeological conditions at the site.
- 5) What geological inputs would be necessary for geotechnical or other engineered design?

- 6) What geological conditions would likely impact construction?
- 7) Were there any geologic conditions of importance in the surrounding volume of earth materials, off the project footprint?
- 8) How would construction, operation and maintenance affect the project ground and the ground adjacent to the project?
- 9) Now, get on with your conclusions and recommendations!

Surely there was consternation and frustration over being “handed” seemingly unsolvable problems, but we lumped it and got on with each task at hand, and benefited soundly from that drubbing in practice.

All this became known among his first (1960s) graduate students as “Lacy Think,” out of a vague recognition of the pop-culture term for the teachings of the then dictator of China. AEG Past President Richard J. Proctor recalls that Arizona alum Marshall Payne passed his notes on Lacy courses as background for Richard’s decade of adjunct engineering geology course instruction at Caltech in the 1970s and that there’s “Lots of good stuff there.”

11.0 OFF to AUSTRALIA (1971)

Minds like those of Bill Lacy become restless once the goal is realistically or pragmatically fulfilled. Several of this points in Bill’s life are recognizable and the call to Australia came in 1971. Hatheway remembers this event well, for he was working in Los Angeles for LeRoy Crandall & Associates when Bill called on the day of the San Fernando earthquake (17 February) to say that the dissertation would have to be completed, submitted and defended not later than that May, because of his planned December departure to join the James Cook University (JCU), Townsville, North Queensland. Bill’s new venture was to be as Foundation Professor of Geology, one of those opportunities that are hard to pass up.

11.1 How Bill Lacy “Discovered” Australia

Bill had been introduced to Australia back in 1967 as a six-month Fulbright Fellow to the University of Queensland, at Brisbane. He taught courses on “Ore Deposits” and “Rock Mechanics”, and gave lectures at the newly established

James Cook University, at Townsville. One of his Arizona students, Ken Cornelius, was working on a doctoral dissertation at the Mount Morgan mine, so Bill was given a special reception there, and his performance generated a acquisition-gestation period of four years, followed by the James Cook University offer. None of we Lacy graduates could fault him for taking that bait. What we did not know then was that the offer came simultaneously with the dreaded incorporation of the Arizona College of Mines into the College of Engineering. With this loss of identify, Bill had no second thoughts about pulling up his Arizona stakes and answering the Townsville calling, departing in December 1971. At that time, he had also been approached to consider serving as Dean of Mines at the University of Alaska.

11.2 Lacy Innovation at James Cook University (1972-1979)

Once in Australia, Bill Lacy applied his lessons-learned from educational program building at Arizona, to the unique opportunities fostered by the burgeoning Australian extractive minerals industry. A year had been lost (1973) in furthering his organizational development goals, due to the need to switch classrooms and laboratories from the Pimlico satellite campus to the main university campus five miles away, at Douglas, where a new Geology Building had been completed.

The not-too Scottish Lacys were met by a largely Scottish faculty at JCU. Part of the campus faculty initiation was learning to eat and passably enjoy haggis, served with boiled potatoes and turnips. Bill claims that this mixture of sheep leavings, served on "Burn Night," the 25th of January observance of Robert Burns, was "really quite palatable." Bill does not link consumption of haggis with the following jolting event.

On 31 August, 1975, Bill suffered a heart attack during his and Jo's vigorous indulgence in the vigorous "Mexican Hat Dance" at a University function. Bill used his recovery as an excuse to decline attendance at the usually frustrating Academic Board meetings, in favor of road-running to build up the heart capacity. After three months of active convalescence, Bill linked up with Roger Taylor a towering figure in Australian minerals exploration and learned of the Down Under deficiency in the economics and concepts of integrated exploration, mining and metallurgy, and business philosophy in the various geology curricula to properly prepare students for a career in industry.

Taylor already was on the JCU faculty and, with Lacy, concluded that it would be beneficial to put together an MSc course that would allow working geologists to use their holiday periods, plus an additional educational break allowed by the participating company, to attend concentrated two-week short courses at James Cook University.

Taylor laid heavily on teaching and blessing the program, and Lacy leaned into making the venture mechanically “happen” as well as co-teaching with Roger. Students would be required to prepare seminar presentations and prepare research theses based upon geological and economic problems encountered at their place of work. Lecturers from industry would be invited to present subjects not within the direct expertise of the James Cook academic staff. It was a revolutionary idea, not welcomed by the Academic Board, who declared that it lacked academic excellence. Finally the Board approved introduction of the course with the stipulation that no money would be assigned to its operation.

Convinced of the relevance of this new mission, Bill toured the offices of mining companies in Brisbane, Sydney and Melbourne. By way of these visits, he stimulated interest on the part of various companies and secured their pledges of financial support to get the program off the ground, and, developed additional scholarship support from the Exxon, Getty and Mount Isa companies. The program proved to be a success and hundreds of ambitious geologists have found the program to be a key to success in industry and now serve in executive positions within the industry – a source of employment for James Cook graduates and support for post-graduate research. The program stabilized at about 20 students at any given time.

9.2 Australian Mineral Foundation (AMF), of Adelaide

Bill fondly recalls the open-door AMF invitation to develop and present short-courses on various topics for the mining industry generally. In the course of his ten-year Australian practice, he presented 15 separate AMF courses, on such topics as Porphyry Copper Deposits, Mining Geology, Precious Metal Deposits, and Exploration Management in Adelaide, Papua New Guinea, and the Philippines. Bill found the AMF to be unique in the world, fulfilling the wholly useful function of updating those in the minerals industry as to technological and economic developments in

the field. The AMF program greatly enlarged Bill's industrial contacts and many consulting assignments flow from that association. Of these, peripheral involvement (1972-1975) in the massive OK Tedi copper development (Kennecott Corporation) on Papua New Guinea was the most magnificent. It is well known that Bill diverted all of his own consulting fees to cash support of student and department needs back at JCU.

9.3 The Mining and Metallurgy Documentary Film (1977-1980)

Bill's teaching engagement at JCU afforded a half-year sabbatical leave in 1977 and this opportunity fortunately coincided with an inquiry from Conzinc Riotinto Australia Pty. Ltd. (CRA) , asking for a proposal for a TV documentary concerning the impact that mining and metallurgy had on man's social, economic and technological development over history -- *Out of the Fiery Furnace*. Bill was hooked and referred to his earlier study for the United States Public Land Law Review Commission. The proposal met with approval, and CRA agreed to reimburse the University for the six-months' salary, for the Geology Department to hire a temporary instructor to cover some of his teaching obligations at JCU. In addition, they agreed to cover travel expenses and assured him of a world tour to visit museums and historical sites throughout the world. At no net cost, the University was able to gain favorable publicity from the documentary series. However, in accordance with the frailties of human nature, the agreement set some uncomfortable precedence at the university that irritated some of the academic staff in other departments.

Bill's main effort in developing the textural materials was performed in 1977, but it was not until the spring and winter of 1980-1981 that the actual filming occurred, in a tightly-maintained worldwide schedule of travel and visits. The film was screened internationally in 1984. Bill contends that this effort constitutes his greatest writing contribution to the minerals industry, through its linking of fundamentals for the greater pursuit of the study and development of economic mineral deposits. We agree with Bill that the time has come to revise and reissue this message!

9.4 Lacy Gears Down at James Cook University (1979-1982)

With his main JCU goals achieved, Bill resigned from his

Foundation Chair in July, 1979, and was honored by a newly created “Personal Chair” in Geology which stipulated that he be allowed to devote his time and energies solely to teaching and advising. At age 65, in 1982, Australian employment rules called for mandatory retirement (**Fig. 9**). Before leaving Australia, Bill set up “Lacy & Associates: Geological and Geotechnical Consultants and Mine Appraisals - Townsville, Queensland, Australia.” Bill admits that there were no “associates” but the room was open. Shortly thereafter, in 1982, back in the States, he was contacted by Al Perry, an old Arizona mining geologist friend from Arizona, asking for Bill’s assistance in providing evidence of his employability, in the latter’s request for an Australian resident visa. Bill accommodated Perry, although he worked independently and soon became well established.

9.5 Lacy Returns to The States -- 1983

Bill and Jo returned to the States in 1983, at which time he took retirement from his 27 years of teaching and academic administration, and turned his attention to consulting assignments, on a more leisurely basis. The Lacys picked the new Green Valley development in which to purchase a new home, with fine scenic backyard views of the Santa Rita Range and the ghost town site of Helvetia. Bill rented an apartment in the complex and set up shop. Assignments came quickly for solutions to the unanticipated development problems associated with land utilization in the area, which generally was down-alluvial fan from abandoned 19th century mines; cloudburst drainage protection, groundwater contamination and blowing tailings dust. Paying clients in Arizona and New Mexico brought forth a variety of mineral claim work; establishing mining possibility, disproving possibilities, and enabling of claim and title consolidation.

In addition to this activity, the Lacys joined the local Presbyterian church and both sang in the choir, while Jo went back to her competitive swimming activity, from local to international.

With some time on his hands at Green Valley, Bill then compiled and edited a volume in Geology Benchmark Series (1983) on *Mining Geology*, with about half the content on engineering geologic and geotechnical topics with which he was most

familiar, to serve as a review of examples of successes in mineral deposit development. In this book, Bill turned mainly to old faculty and visiting faculty allies as contributing authors.

Consistent with the ongoing age of Arizona's reassessment of old claims, the Mormon Church, through a bishop and former Lacy student, asked for pro-bono assistance in evaluation of Church properties at Safford and Morenci. Properly managed, Bill notes that royalties from the claims now have yielded major financial benefit to that church.

On the paying side of consulting, retirement-era Lacy clients have been Mount Isa Mines, Carpentaria Exploration, Utah International Minerals, CRA Ltd., Bougainville Copper Corp., BHP Ltd., Anglo American Co., Northern Territory Chamber of Mines, Papua New Guinea Government, AHI New and Zealand, Exxon Corp., Superior Oil Co. The range of assignments included the usual mix of Lacy competence; development and evaluation new and existing exploration programs and staffs, feasibility evaluation and economic analyses of mineral prospects and mines, taxation assessments, slope stability, plant site selection, and muck handling considerations.

At Mount Isa, Sepic River area of Papua New Guinea, Lacy arrived by helicopter and was feted to an elaborate in-ground, pit-type pig roast, with chunks the price piece, liver offered to the guests.

12.0 ACTIVE RETIREMENT (From 1982)

Fortunately the Lacy story is one of a true professional calling, and involvement with the practice of geology does not end with the classical notion of "retirement" but does give way to a continued involvement in the science and the way Bill Lacy always practiced. A Lacy hallmark is that once he migrated from full-time practice to teaching, in 1955, his consulting endeavors were always conducted to extend his knowledge and to create and exploit only the many opportunities to do more for his students. It is well known that most of the revenue from such assignments went for donations to the extension of his teaching, mainly for expenses to put more students in touch with opportunities for travel, research and publication of their efforts. One

outward sign of the fate of his consulting monies has been his affection for old automobiles of the ordinary variety for his personal use; Fords in the States and Toyotas in Australia; nothing flashy.

Many Lacy graduates and all manner of former clients and professional associates have kept Bill supplied with challenging consulting work in his active post-teaching life. Notable are those who have come across truly knotty applied geoscience problems for which the gravity of the need outdistanced their immediate capability to bite into the substance. That is, those who have been impressed with Lacy Think often are the first to call for Bill's assistance when the need for a timely first-order solution comes in, and they are caught up as too busy to "crack the nut" themselves.

12.1 Lacy is Back in China (1983-1990)

China beckoned again, this time for an extensive deposit evaluation and personnel training program for the block-caving project at Tong Kuang Yu, Shanxi Province, in the mountains of central China. This was a government project, of course, and Lacy brought selected Chinese staff to Tucson, where there were hosted at Lacy-arranged mining operations and he presented basic instruction in rock mechanics applied to block-caving mine design. This was followed by yearly trips of a month at a time, examining geology, drilling records and assay results at Tong Kuang Yu, training the local staff by example and instruction. The Chinese spiced these trips with many side tours to rural countryside points of interest. On his way out of China on a 1990 visit, Bill stopped at Beijing and was present, with interpreter, on the day before the so-called Tinnamin Square "massacre" (**Fig. 10**). Bill is a staunch proponent of democracy, but his years in China also provoke him to proclaim that the freedoms would generate famines.

Also on the 1990 trip, during cold weather, Bill fell to a case of "double" pneumonia and the mine administration responded heroically by shipping the ailing American to the "American Hospital" at Beijing, where the only available medicine was penicillin. Fearing the potential death of a "celebrity" Bill was forthwith shipped by air back to Tucson, where the St. Mary's Hospital staff declared that he would have been luck to have survived another three days without their care. Two weeks later, Bill was

back on his feet only to find that Jo had sold the small Green Valley house and had bought a larger replacement and had moved the outfit in, all for a surprise!

12.2 A Move Back into Tucson (1995)

The Lacys sold out of Green Valley and went back up to Tucson and entered an “Active Retirement Community.” Bill rented nearby office space and things were stable until Jo’s death in 2000, when Bill brought his office back to the apartment. This also recognized that Bill’s office insurance was cancelled when the insurers learned that he “entered mines,” so an office at home became essential.

12.3 Worldwide Mining Venture Evaluation (1996)

Early in 1996, Bill’s old client CRA was merging into Rio Tinto Zinc, and Bill was requested to join exploration delegates of each of the companies, to evaluate their existing worldwide exploration programs. Here the menu included Australia, Papua New Guinea, Laos, Philippines, Indonesia, USA, Canada, Alaska, Mexico, Argentina, Brazil, Chile, Peru, Ecuador, France, Central Europe, Sweden, Zimbabwe, Zaire, and South Africa. Travel was included and was by chartered planes and helicopters, with city lodging in first-class hotels and field accommodations a la primitiva.

Bill missed only Laos on the worldwide scamper, due to a urinary infection from South Africa and a hasty return to Tucson, with temperature of 106 F, accompanied by cardiac arrest and an ice pack. Back in the conscious world, Bill was told that 106 degrees “cooks the brain” and he now offers this excuse for occasional memory lapses.

12.4 Lacy in Guyana (1996)

Here Bill recalls that the Winters Company, a highly successful mineral economics firm created by his 1966 MS graduate Harry Winters, called on him in 1996 to visit Guyana. Here the tailings dam at the remote Omai Gold Mine had failed due to time-decrepitation of native soils used to construct its embankment. The end result of this geochemical leach-and-weathering process was piping and total loss of retention integrity, releasing cyanide solutions and slimes in the major Essequibo River System. Emergency remediation was underway when Lacy arrived, without a clear understanding of what had likely caused the failure. After Lacy’s evaluation, prior to

his departure, at least the cause and most likely mechanism of the failure had been worked out.

12.5 Further Adventures

As one would expect, Bill keeps plugging on, thankfully not knowing other than to be as active as possible in his professional calling.

The Rio Tinto “tour” in 1996 had included a visit his old mining ground in Peru, at the Toro Mocho mine (17,000 feet of elevation), with an over-night stay at the old “home” town of La Oroya. Nationalization had brought the Cerro de Pasco holdings into Centromin, the Peruvian Government Mining Company, but the properties were now being put up for capitalized operation. Lacy was to inspect Toro Mocho, which Bill thought well of this prospect but his recommendation did not carry the day with RTZ. Bill recalls that when reporters from the local newspaper at the town of Cerro de Pasco came to interview him, he was not able to respond with his usual fluency in Spanish, hinting a bit of the results of the Chinese pneumonia “cooking.” Bill now recalls that J. David Lowell, now famous for his magnificent call on the San Manuel (Arizona) copper deposit extension, through the use of presciently-good geologic deduction, to identify the missing portion of the ore body, came forth in 2002 to acquire an option on Toro Mocho! (Fig. 11)

Lacy’s career had now come full circle as his doctoral dissertation provided valuable tools for Toro Mocho’s ore-deposit interpretation and a confirmatory return to the site in 2004.

For Bill’s 85th birthday present in 2001, the Lacy family provided him with a geologic walking tour of that specially scenic portion of the Lewis & Clark 1804-1806 expedition Lolo Pass crossing of the Bitterroot Mountains of Montana. This year (2005) Bill was treated to a five-hour horseback visit to the *Planchas de Plata* claims just inside Mexico, from the Arizona border. With a bit of help getting leg-over-saddle Bill went on to assess the visual aspects of mineralization potential and “wore skin off my butt.” Outwardly, Bill senses some resemblances to the undeveloped portions of the famous Cananea deposit of the same Sonora State.

12.6 Bill Returns to Peru (1996)

11.0 SOCIETY INVOLVEMENT and PROFESSIONAL REGISTRATION

We fresh graduate students were largely unaware of the nature and intricacies of professional registration. But that level of blissful ignorance ended early and directly and we all began to plan our ways toward that goal. Suffice it to say that geological engineers in the U.S. are basically qualified to become licensed both as scientists (geologists) and as engineers. The former was a more direct challenge, but it was not until 1969 that California picked up Arizona's 1921 torch and launched the now highly successful trend toward geologist registration, now available in 27 of the States. Engineering licensure presented some problems as well, as no State recognized Geological Engineering as a separate discipline and we all were forced to prepare for and sit for the examinations either in Civil or Mining Engineering.

After most of us had taken either route, Arizona stepped forward in 1970 with licensure of Geological Engineers, as Professional Engineers. The route was no less difficult, but more direct. At this point, the authors have not been able to uncover to whom goes the credit for creating this professional registration, but Bill recalls that it was he who prepared and graded the initial qualification exams.

12.0 HONORS

It is significant that Willard C. Lacy's intense involvement in the profession was signaled by C.C. Mathewson's movement to seek award of Honorary Membership in the Association of Engineering Geologists for Bill. Mathewson, who had spent his own post-Arizona career teaching Engineering Geology at Texas A&M University and spreading Lacy Think. The award was made at the 1992 Annual Meeting of the Association (Mathewson, 1993).

In the following year, 4 December, 1993, Bill was honored with a Medal of Merit by the Mining Foundation of the Southwest at its annual American Hall of Fame banquet and awards program , at which son John delivered the following remark:

"I think that the true measure of Dad is his love of teaching. He is very proud of the achievements of his students and has frequently gone out of his way to help those in need -- including bailing one out of jail. He is also constantly seeking new ways to offer his

knowledge to others.”

On receipt of that same honor, Lacy had this to say in acceptance:

" Friends -

It is particularly rewarding to, in a small way, share the award ceremony with the honoring of George Hearst*. Ten year of my early mine experience were spent in the mines of the Cerro de Pasco Company in Peru (Later the Cerro Corporation), founded by the Hearst interest in 1901. This rewarding experience in a series of classical mineral deposits formed an important part of the foundation for my teaching career.

But, it seems that my students, while remembering some of the things I taught (some right and some wrong), tend to remember the exams. I always felt that an examination should be a learning experience and, at a graduate level, all exams were take-home exams where students could consult with any book or person. The catch, however, was that the questions had no answers, and the grade was based upon the approach to unanswerable questions. Students have come back later to tell me that this was the greatest experience they had in preparing them for the real world.

I suppose it was a little like an exploration experience. One never knew on starting out on an exploration trip in the Andes what sort of a situation would be encountered. On one such trip our mules got into a variety of 'loco weed' and began to bloat. What happens is - they fill up with gas, lie down, and will die of cardiac arrest. We were fortunate in having a young Peruvian geologist, Tony Porturas, who had an answer to the situation.

Footnote:

*Reference is made here to the historic mine development figure, the late Senator George Hearst, the Missouri dirt farmer who brought copper fully into the North American mining panoply at Butte, Montana, and who sired the famous family newspaper magnate.

Perhaps in many ways the exam problems served in somewhat similar fashion as the alcohol-soaked wads -- even some of the less enthusiastic students seemed stimulated....." He took out the first-aid kit and removed the cotton batting, soaked wads of

cotton in alcohol and stuffed the wad under the mules tail -- then lit it. The mules responded to the treatment by jumping up, running around, and releasing the gas in loud explosive blasts. Tony was able to save all the mules.

Down Under, Bill was awarded the Essington Lewis Lectureship in 1971 by the Australasian Institute of Mining and Metallurgy (AIMM), which, in 1990, awarded Bill an Honorary Fellowship. After his departure, the University of Arizona recognized Bill with its Distinguished Citizen Award, in 1974.

Surely a secondary honor for Bill was the 2004 election of his own economic geology student, Prof. (Dr.) Spencer Titley, to the National Academy of Engineering, in recognition of Spence's preeminence in the knowledge of the origin and exploration characteristics of porphyry copper deposits.

13.0 SUMMARY

We salute Willard C. Lacy as one of the founders of the last and most modern version of the profession of Geological Engineering. Lacy's brand of Geological Engineering sought adherents who were fearless in their determination to advance the profession and to further honor its earlier practitioners through gaining a thorough appreciation of practical engineering principles and to infuse forthright site geologic observations, interpretations, assessments, evaluations and recommendations into the work product of all manner of other engineers involved in construction, natural resource conservation and development, and lastly, with environmental protection.

ACKNOWLEDGMENTS

The authors hatched this plan over a fine salmon dinner at the Klingmueller's urban horse ranch at Lakewood, Colorado, on 9 June, 2005. We were in contact with Bill within days and he allowed only that he would put the proposition to his son John, long-time Tucson mining attorney. John broke the news that indeed his dad had already recently set much of the story down in a series of recollections and that these would be shared with us. We were off! During this effort, Dr. William K. Smith (USGS, retired, Arvada, CO), also an early Lacy graduate student at Arizona) has been of much help in recollections and in trimming "loose ends." Richard J. Proctor is also thanked for his pre-submittal review of the manuscript.

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FIGURES

1. 1918, Nanking, China, Willard C. Lacy, standing, front left, with other missionary children and their nannies.
2. 1934, Bill Lacy as a graduate of Aurora High School, Aurora, Ohio
3. 1938, DePauw University's graduating of BS Chemists, all of whom eventually received doctorates. Bill Lacy is second from right, first row.
4. 1940: Bill Lacy going about early doctoral field mapping near Sunridge, Ontario, Canada.
5. 1940: Bill and Jo Lacy, shortly after their marriage at Sunridge, Ontario, at the time he was a green doctoral candidate and mineralogy course teaching assistant in the Geology Department at Harvard University.
6. 1944: Aviation Ordnance Officer, Ensign Lacy, U.S. Navy.
7. 1946: Lt (jg) Lacy (right) receives the Navy Commendation Medal at Oakland Naval Ordnance Terminal, California.
8. 1951: Assistant Chief Geologist Lacy with the Cerro de Pasco geological staff; from the left, Ken Fox, Bill Lacy, Al Engeln, Bob Koenig, and Reg Bemis, Peru.
9. 1980: Professor Lacy is honored at his retirement party, Geology Department, James Cook University, North Queensland, Australia. The custom-designed statuette is a caricature of the retiree.
10. 2000: Geological consultant Lacy at work in China, here shown at Tiananmen Square, Beijing.
11. 2002: Bill and eldest child John at Toro Mocho, property, Peru, 17,000 feet straight up, and still looking for viable copper! Ticlio Peak is in the background.

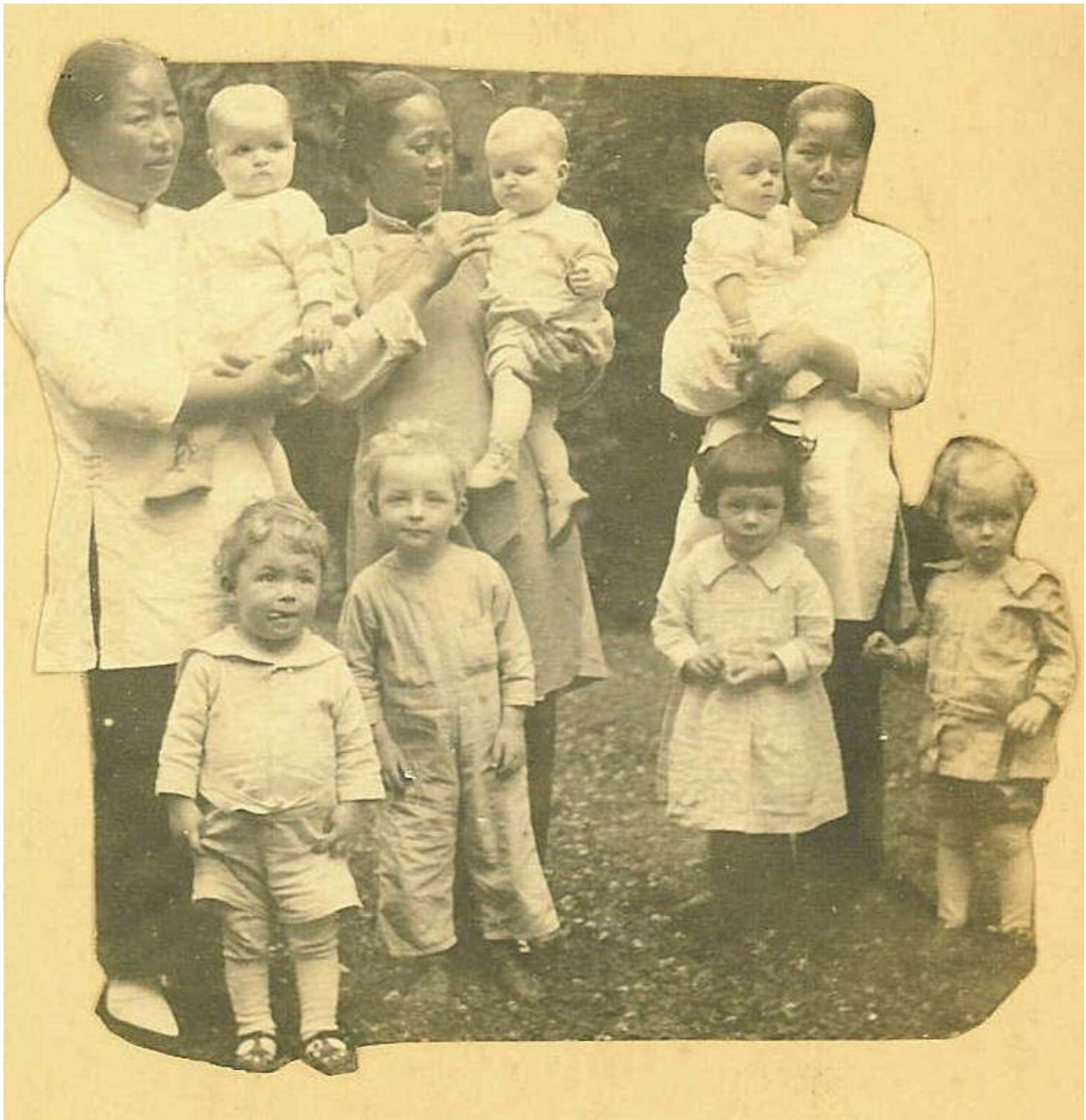


Fig. 1 1918, Nanking, China, Willard C. Lacy, standing, front left, with other missionary children and their nannies.

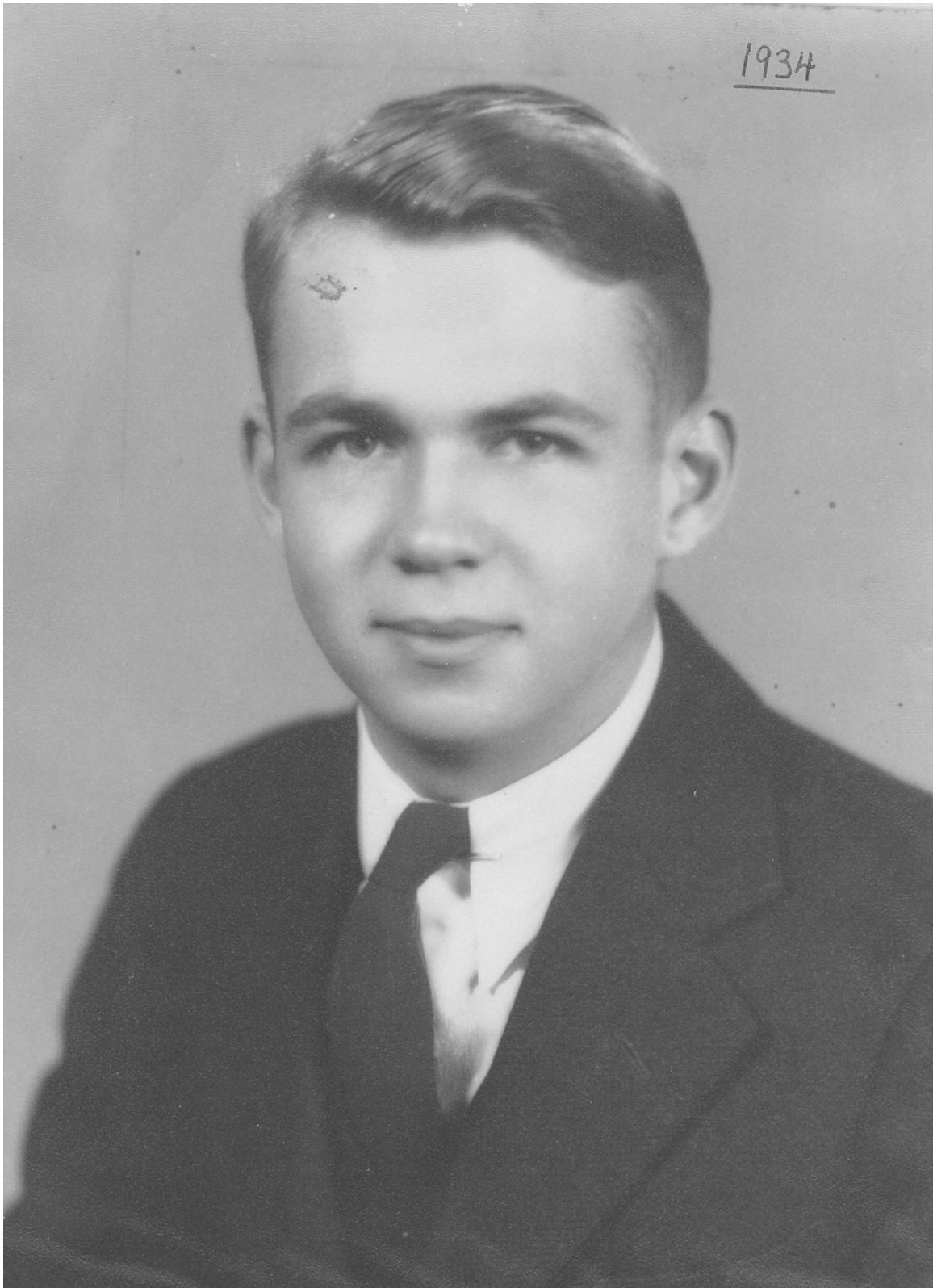


Fig. 2 1934, Bill Lacy as a graduate of Aurora High School, Aurora, Ohio

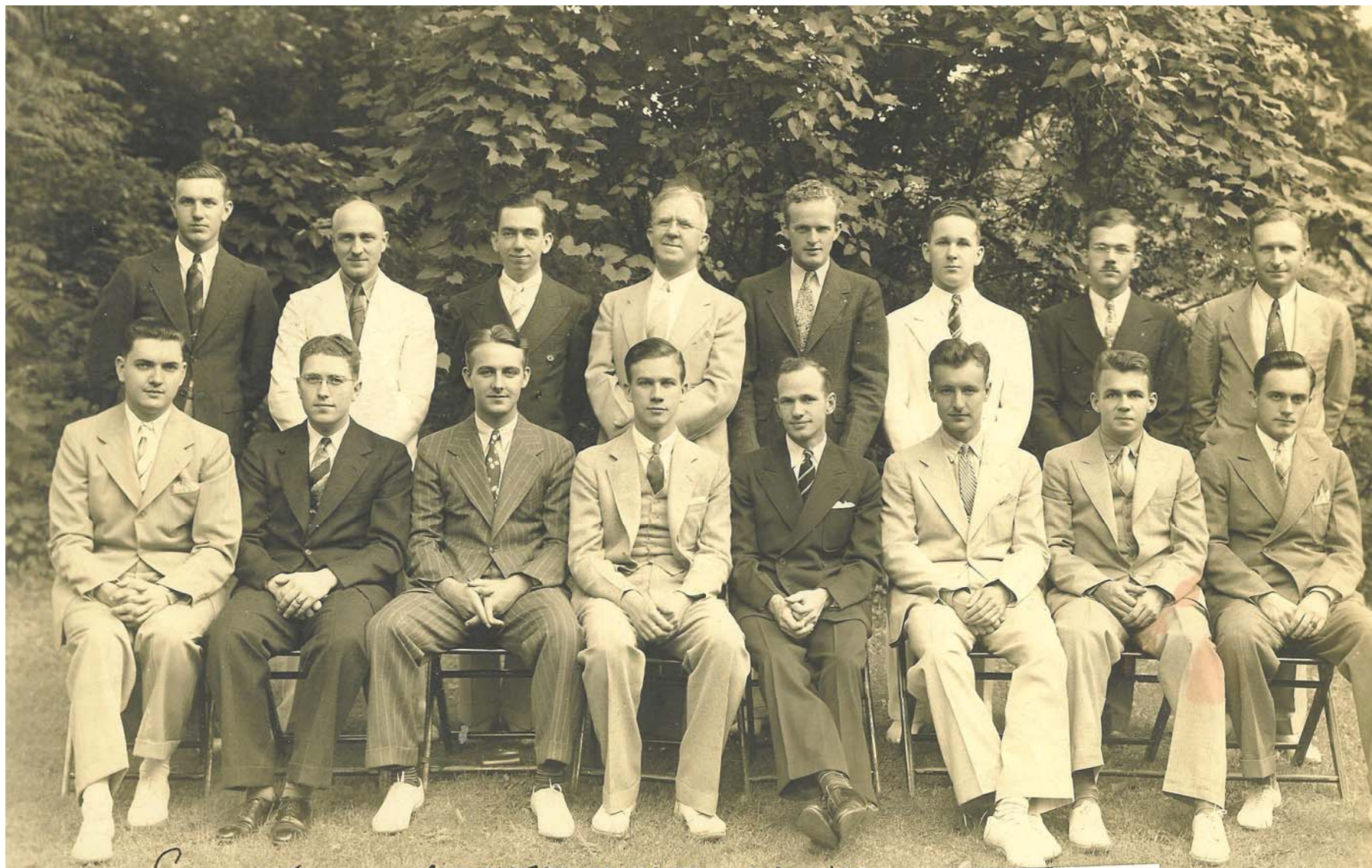


Fig. 3 1938, DePauw University's graduating of BS Chemists, all of whom eventually received doctorates. Bill Lacy is second from right, first row.

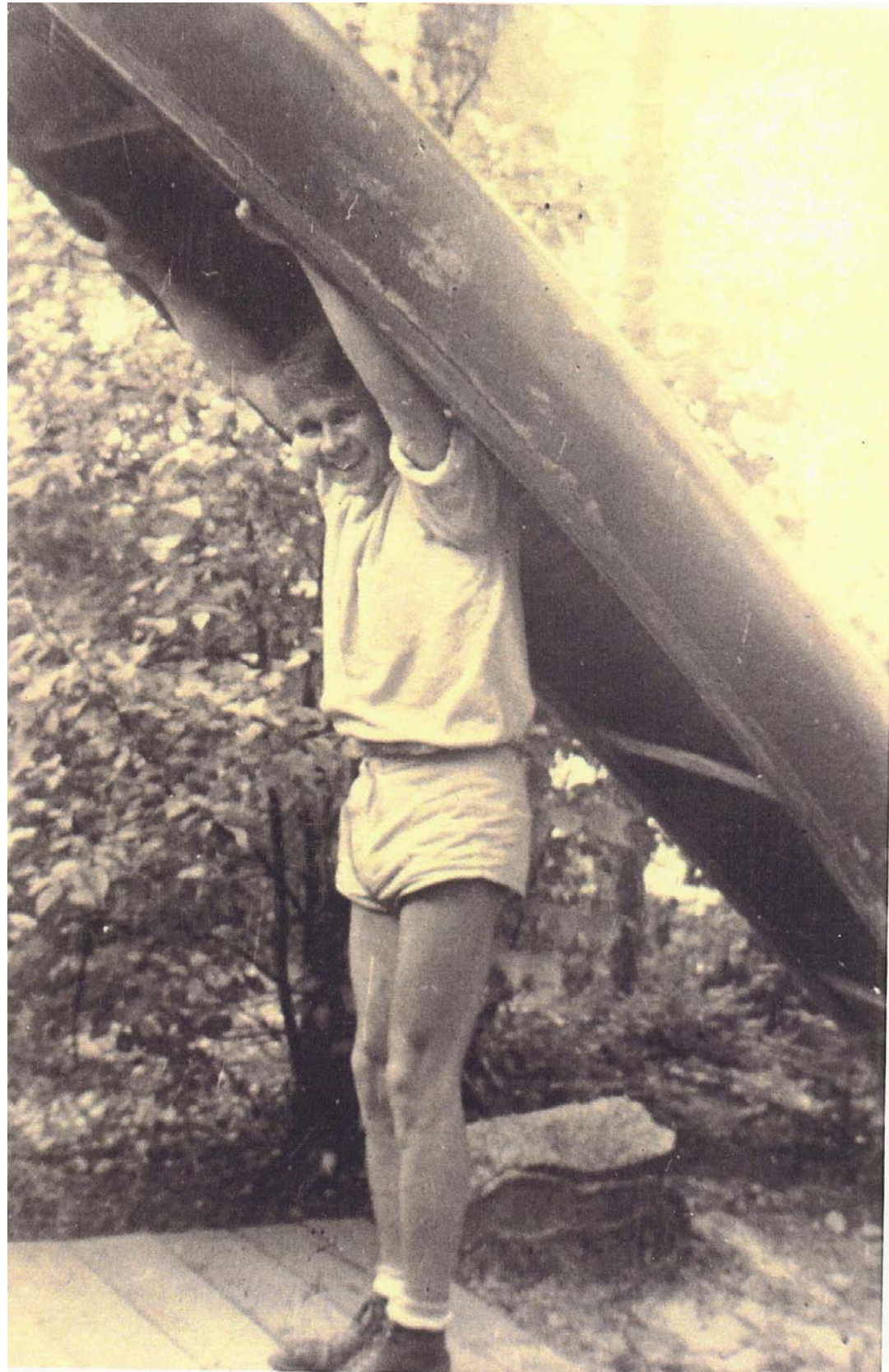


Fig. 4

1940: Bill Lacy going about early doctoral field mapping near Sunridge, Ontario, Canada. Bill's dissertation topic changed to encompass economic geologic assessments of copper deposits in Peru, after World War II.



Fig. 5.

1940: Bill and Jo Lacy, shortly after their marriage at Sunridge, Ontario, at the time he was a green doctoral candidate and mineralogy course teaching assistant in the Geology Department at Harvard University.



Fig. 6. 1944: Aviation Ordnance Officer, Ensign Lacy, U.S. Navy.



Fig. 7.

1946: Lt (j.g.) Lacy (right) receives the Navy Commendation Medal at Oakland Naval Ordnance Terminal, California.



Fig. 8 1951: Assistant Chief Geologist Lacy with the Cerro de Pasco geological staff; from the left, Ken Fox, Bill Lacy, Al Engeln, Bob Koenig, and Reg Bemis, on duty in Peru. Koenig, obviously an old soldier, stands at

parade rest, hands out of pockets, accoutered in Army pistol belt and Army field jacket.



Fig. 9

1980: Professor Lacy is honored at his retirement party, Geology Department, James Cook University, North Queensland, Australia. The custom-designed statuette is a caricature of the retiree.



Fig. 10

1986: Geological consultant Lacy at work in China, here shown at Tiananmen Square, Beijing.



Fig. 11 2002: Bill and eldest child John at Toro Mocho, property, Peru, 17,000 feet straight up, and still looking for viable copper! Ticlio Peak is in the background.