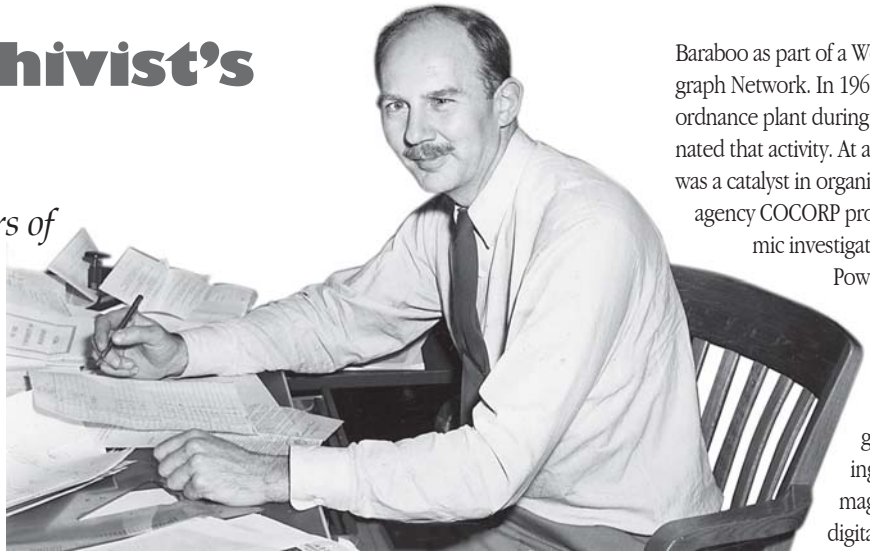
The Archivist's Corner

The first thirty years of Geophysics at UW-Madison

by Robert H. Dott, Jr.



"Mr. Gravity," George Woollard. in 1962. *(Department archives)*

This, the fourth International Polar Year[1] and the fiftieth anniversary of the International Geophysical Year (IGY) of 1957-58, is an appropriate occasion to review the early history of geophysics in our department. Although Louis B. Slichter initiated an embryonic program here in 1945, he left two years later to become the first director of a Geophysics Institute at UCLA. Therefore, our program really began with George P. Woollard, who came in 1949.

George was a charismatic man, whose charm easily persuaded young students to sign up for geophysical field projects and see the world. In 1955 a young reporter for the Christian Science Monitor interviewed him and was so captivated that he left Woollard's office with a gravity meter and a plane ticket. Gravity was George's first love, so it was natural that when "Mr. Gravity" arrived in Madison, he would immediately mount a program to expand the coverage of gravity and also magnetic observations across North America. To do this required many people to carry instruments to countless localities, so George began recruiting a small army of young men from geology, physics, engineering and assorted other disciplines—even journalism and economics. The initial recruits in turn often recruited friends and friends of friends. Among these were John Rose and Bob Meyer fresh from physics, who became two of Woollard's first PhD students together with William Bonini, William Hinze, John Sumner, and John Mack. Both Meyer and Rose became Instructors in the department in 1955 and Meyer continued as professor. Other Woollard protégées who later held faculty appointments were Ned Ostenso, John Steinhart, and Nik Christensen.

One by-product of the cold war was generous federal support for many of the sciences. As the cold war heated up in the 1950s, the Department of Defense provided support for geodesy, refinement of which was critical for missile guidance. Accordingly, George received a large contract to support his gravity program as well as support for crustal seismology investigations. Nuclear testing gave a spurt to seismology because a greater knowledge of the earth's crust was needed to enhance the detection of underground nuclear tests. Marine sciences were also stimulated because of the need for better submarine detection with underwater acoustical methods, which in turn required refined resolution of bottom topography.

During the 1950s, Bob Meyer mounted a vigorous program in crustal seismology, beginning with several seismic traverses across the Atlantic states to investigate the transition from continental to oceanic crust. Both he and Bonini gained the PhD in 1957 from that work. Subsequent large, multi-agency surveys were conducted in Lake Superior, the High Plains, and Canadian Rockies to investigate interior continental crust. Projects were then carried out in foreign regions as well, such as Colombia, Peru, and Bolivia. Through a program of the Carnegie Institution of Washington, Bob had a number of Latin American students, who moved on to distinguished careers in their respective countries. In 1963 he was able to establish an observatory at the Badger Ordnance property at Baraboo as part of a Worldwide Standard Seismograph Network. In 1967 the reactivation of the ordnance plant during the Vietnam War terminated that activity. At about that same time, Bob was a catalyst in organizing the national multi-agency COCORP program of deep crustal seismic investigations. With staff engineer Lee Powell's genius, Meyer pioneered the development of increasingly refined instrumentation for seismic surveys, which progressed from analog recording on photographic paper, to magnetic tape, and finally to digital recording. The Wisconsin team introduced the newest technology to other agencies, including the Carnegie Institute of Washington, the U.S. Geological Survey, and other universities. Bob's projects required large teams of people working shoulder to shoulder as apprentices. Each and every person, whether student or technical staff member, participated in all phases of a project from preparing grant proposals to soldering circuits as well as co-authoring the resulting publications. The group was like an extended family.

Bob Meyer's caravan of UW vehicles and a boat leave Madison for accoustical testing in Cape Girardeau, Missouri, 1962. *(Courtesy of Bill Unger)*

In the mid-fifties, planning for the International Geophysical Year of 1957-58 began and this effort was to bring more funding to certain sciences. Politically astute Wollard formed the Geophysical and Polar Research Center at the University and obtained an NSF grant for the analysis of data from IGY over-snow seismic traverses in Antarctica. Charles Bentley, who had been a principal leader of some of the IGY traverses, faced a Hobson's choice: he could either give up the data he had spent two years collecting or come to Wisconsin to work them up. He did the latter (happily enough) in 1959. Wisconsinites Ostenso, Hugh Bennett and John Behrendt, along with Michigan graduate Edwin Robinson, all of whom had also worked on Antarctic traverses, were now his office mates.

Other Badgers who were important participants in Antarctic over-snow and airborne traverses during and after the IGY, were Edward C. Thiel and John C. Behrendt. Thiel was an early Woollard recruit, who received the PhD in 1955. He was the lead seismologist for a long traverse inland toward the South Pole from the Weddell Sea coast with the younger Behrendt as his assistant (1956-58). Thiel continued to lead geophysical surveys in other parts of Antarctica until his untimely death in 1961 in an aircraft accident at Wilkes Station; he had just recently joined the faculty of the University of Minnesota. Behrendt, another Woollard recruit from physics, returned to Antarctica over the next four decades for a total of 12 expeditions. He re-

ceived the PhD from Wisconsin in 1961 just days before returning to Antarctica for his last Wisconsin-sponsored survey. In 1964 John joined the U.S. Geological Survey and continued to go to Antarctica intermittently until 1994. He has published two memoirs of his sometimes hair-raising adventures on the polar continent. Richard Wold, who assisted Behrendt and others on several traverses, joined the faculty of the University of Wisconsin's Milwaukee campus after receiving the PhD. Likewise, Thomas Laudon, who had accompanied Behrendt, joined the faculty of the University of Wisconsin at Oshkosh.

Professor Bob Meyer, left and laboratory technician David Schlabach load research gear onto the Coast Guard cutter *Woodrush,* in preparation for seismic surveys in Lake Superior, 1964. *(Department archives)*

Two staff members of the Geophysical and Polar Research Center from this period, who have played several different roles, are William Unger and Lee Powell.

Bill, who graduated in geology (BS 1960), was recruited by Bob Meyer while still a student to clean out the geophysics garage. Recognizing Bill's other unique talents, Bob hired him permanently and he served as a "masterful jack-of-all-trades" for nearly five decades. He participated in many field experiments and was responsible for the design and fabrication of several types of seismological equipment. He has helped faculty members in geology as well as geophysics in proposal preparation, procuring equipment, and generally helping people with all manner of problems. Bill has been a modest, unflappable "Mr. Fixit" with a genius for making things work.

Lee graduated in electrical engineering (BS 1965) and was recruited by Meyer in 1964 to assist with the technical preparation of seismological instrumentation for land and marine data collection systems. Lee's talent for design and understanding of both the technological and scientific aspects of Bob's program was quickly recognized and his career as an instrumentation innovator continues today. Lee participated in the field deployment of the equipment he designed, for Bob knew that both designs and designer would benefit. Lee's keen engineering abilities allowed Meyer's program to flourish; many of his design philosophies were used in the NSF-sponsored inter-agency program for the development of portable seismic instruments (IRIS). Since 1980, Lee has provided innovative solutions and ideas for the entire department.

By 1960 the geophysics program had become so large and complex that Woollard delegated the supervision of various individual components. Meyer directed crustal seismology, Ostenso an Arctic program, and newcomer Bentley with Ed Thiel co-directed a growing Antarctic program. Then in 1962, having launched this vigorous and varied program at Wisconsin, George accepted an invitation to direct the newly established Hawaii Institute of Geophysics. John Rose and half a dozen other, non-faculty members of our Geophysical and Polar Research Center followed George into the sunset. In 1966 Ostenso moved to Washington, first to the Office of Naval Research and later to NOAA, where he became Director of the National Sea Grant Program and Assistant Administrator for Oceanic and Atmospheric Research.

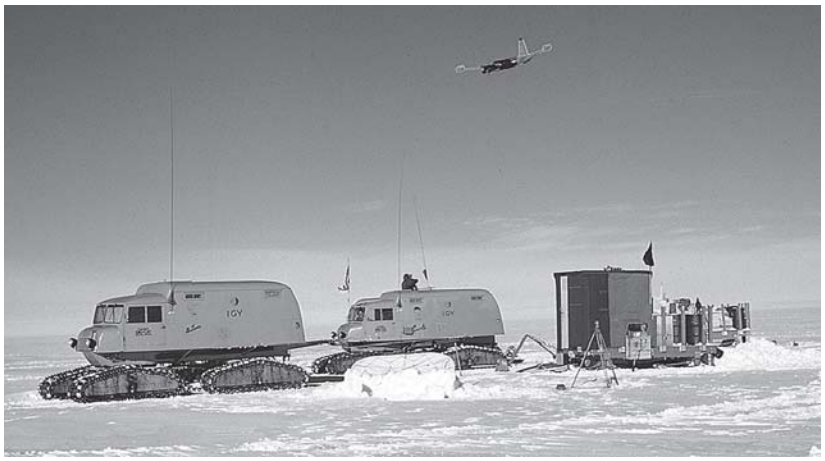
Bentley continued after the IGY to lead geophysical studies of the Antarctic ice sheet and the crust beneath under an NSF Polar Program. During the 1960s and 1970s, IGY-type traverses were supplemented with other methods. For example, his group pioneered the use of radar sounding of both the thickness and radio anisotropy of the glacial ice, first via over-snow traverses and then by airborne surveys. Electrical resistivity measurements of the ice were also made. A particular focus has been on the ice sheet of West Antarctica, much of which lies on a bed far below sea level. In the 1980s and 1990s, his group studied ice thickness, ice properties, and basal conditions of several fast-moving ice streams, knowledge of which is needed to understand the past and present dynamics of the ice sheet. After his retirement from the Department in 1998, he took up his main current activity as Principal Investigator for Ice Coring and Drilling Services, a division of the Space Science and Engineering Center, which supports NSF investigators in Antarctica, Greenland, and elsewhere. Greater knowledge of the great ice caps has taken on new meaning in light of global warming. For his extensive contributions to glaciological research, Bentley was awarded the Seligman Crystal of the International Glaciological Society in 1990.

Sigmund Hammer came to the department in 1967 after retiring from the Gulf Research and Development Company. Like Woollard, he was a gravity specialist and had been the principal developer of the famous Gulf Gravimeter. He was President of the Society of Exploration Geophysics in 1951-52 and was elected that society's Honorary Member as a "Pioneer in Exploration Geophysics." He once detected with a gravimeter the fact that the Chrysler Building in Manhattan was missing a floor, something known previously only to its builders (was it No.13?). While with Gulf, Sig also taught geophysical exploration for many years at the University of Pittsburgh. He brought that experience to Wisconsin, where he taught for five more years. After retiring here, he worked through a United Nations program to enhance the development of geophysics in Bolivia and Turkey.

In 1967 Clarence Clay was appointed professor in marine geophysics. With his PhD in physics from Wisconsin, Clay taught at the University of Wyoming (1950-51) and then joined the Carter Oil Company Research Laboratory in Tulsa. He did wave theory, seismic models, geophone arrays, and seismic well logging research. His science is the role of signal theory in the temporal and spatial aspects of geophysics. In 1955 he moved to Columbia University's Hudson Laboratories in New York and joined Ivan Tolstoy for research in wave and signal propagation in inhomogeneous media (i.e. the ocean and the structure beneath the water). They reported their state of the art in the advanced monograph, ***Ocean Acoustics: Theory and Experiment in Underwater Sound*** (1966). This book and Clay's review paper on the use of arrays in a noisy ocean brought many invitations to give lectures. In 1967, Clay accepted a professorship in oceanographic geophysics in our department. He taught courses in geophysics and oceanography. Oceanography led to an interesting collaboration with the university's fish biologists. The first task was to do lab measurements on the sound scattered by the fish anatomy and then to use sonar to locate and track schools of fish. Clay is the co-author of two additional books: Clay and Medwin, ***Acoustical Oceanography*** (1977) and Medwin and Clay, ***Fundamentals of Acoustical Oceanography*** (1998). The Acoustical Society reprinted ***Ocean Acoustics*** with additions in 1987.

Silver Medals were awarded by the Acoustical Society of America to Tolstoy in 1990, Clay in 1993, and Medwin in 1997. Since retiring, he has become interested in studying climate using time series analysis. In 1972 when he and students imaged the underside of the polar ice pack using side scan sonar, the one-year-old leads of polar ice averaged at least two meters thick and the multi-year leads were much thicker, but they are now less than one meter. Fourier frequency analysis of ice core data from the Antarctic gave Milankovitch periods that are very sharp. Orbital insolation from the sun is a driving force on Earth, but that insolation is decreasing and, from geological history, Clay's analysis suggests we are likely approaching a new ice age. Ewing and Donn (1956) described data for an open Arctic ocean during the last ice age, and Clay wonders if the loss of Arctic sea ice could cause a fast flip into the next ice age.

Ned Ostenso, far left, and Charlie Bentley, far right, with the IGY team at Byrd Station, Antarctica in 1957. *(Courtesy of Charlie Bentley)*



A man in a Sno-Cat hatch watches a reconnaissance P2V fly over the IGY West Antarctic trail party, December 1957. Note the black cooking/dining wannigan on a sled. *(Courtesy of Charlie Bentley)*

In 1970 John S. Steinhart came back to the department in which he had taken the PhD (1960) under Woollard's and Meyer's supervision. During a post-doctoral appointment at the Department of Terrestrial Magnetism in the Carnegie Institution, he continued to study deep crustal seismology until he joined the President's Science Advisory Committee and became increasingly concerned about the role of science in government. When he was invited to join our faculty, he opted for a joint appointment in geophysics and political science. He soon chose to emphasize the critical role of energy in our society and created a very popular course on the subject, which was cross-listed with the Institute of Environmental Sciences. He also developed a course about government and science listed in the Department of Political Science. Needless to say, John's activities in geophysics waned as he became more involved in these other subjects. He was a gifted practitioner of the Socratic method of teaching and his courses were very popular.

Herb Wang joined the group in 1972 and started a new program in rock physics and geodynamics. He and his students have investigated elastic-wave velocities and poroelastic constants in a high-pressure laboratory. Another aspect of Herb's program has been the development and application of numerical models to various geomechanical, hydrogeological, and petrological phenomena. For example, he and students have studied the coupled behavior of stress and pore fluid pressure due to earthquakes and pumping water wells, and he has studied thermal histories of garnet peridotites with Gordon Medaris. Herb has authored a book titled ***Theory of Poroelasticity with Applications to Geomechanics and Hydrogeology*** (2000). In 1998 he accepted an appointment as Associate Dean for Natural Sciences in the College of Letters and Science, a position previously held by our Professor Emeritus David Clark.

The first two International Polar Years[1] and the International Geophysical Year were major international scientific ventures, which were so successful that they should be models for international cooperation on all fronts. Geophysics programs were among the most successful elements of IGY and Wisconsin had a major role therein. It was the vision and drive of George Woollard and perfect timing of his arrival at Madison that made this possible. George was President of the American Geophysical Union in 1964-66 and received the AGU's Bowie Medal in 1973. In 1983, the Geological Society of America created the George P. Woollard Award, which recognizes outstanding contributions to geology using geophysical methods. Walter Mooney, who earned the PhD under Meyer (1979), received the award in 1995. Nikolas Christensen, another Wisconsin geophysics alumnus (PhD 1963) and later a member of our faculty, received the award in 1996.

The Wisconsin IGY efforts had led to the creation of the Geophysical and Polar Research Center within our department, which diversified and grew significantly over the years. When all of the early members of the Center's faculty had retired or departed, the Center as such, having served its purpose, ceased to exist. Herb Wang has now been joined by a new team of young geophysicists bringing new talents and exciting new interests to the Wisconsin earth science program. Chuck DeMets, Kurt Feigl, Cliff Thurber, and Harold Tobin have launched their own world-class programs in geophysics in the tradition of the Woollard team. And so, On Wisconsin! ●

1. The first International Polar Year in 1882-83 was suggested to acquire coordinated measurements of meteorology, ocean currents, glaciers, and geomagnetism. A major motivation was to improve weather forecasting. Twelve nations participated in expeditions to both polar regions. The second Polar Year, fifty years later in 1932-33, was motivated primarily by mysterious disruptions of radio, telegraph, and telephone transmissions. Geophysical studies of magnetics and aurora, as well as meteorology, received emphasis with aircraft and motorized vehicles now available to facilitate the research. The IGY was a broadening of the scope of the IPYs to include more solid earth geophysics as well as atmospheric phenomena. Its timing was dictated by a time of maximum solar activity and it was greatly enhanced by advances in over-snow vehicles, aircraft and now rocketry as well as scientific instrumentation.

NOTE: Charles Bentley, William Unger, Clarence Clay, and Herb Wang provided important input to this story. My apologies to the many former students and staff in geophysics who could not be mentioned in this brief historical over view. Be assured that your contributions are appreciated as much as those that are mentioned.