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# EARTHQUAKE NOTES

EASTERN SECTION

SEISMOLOGICAL SOCIETY OF AMERICA

JUNE 1956

# EARTHQUAKE NOTES

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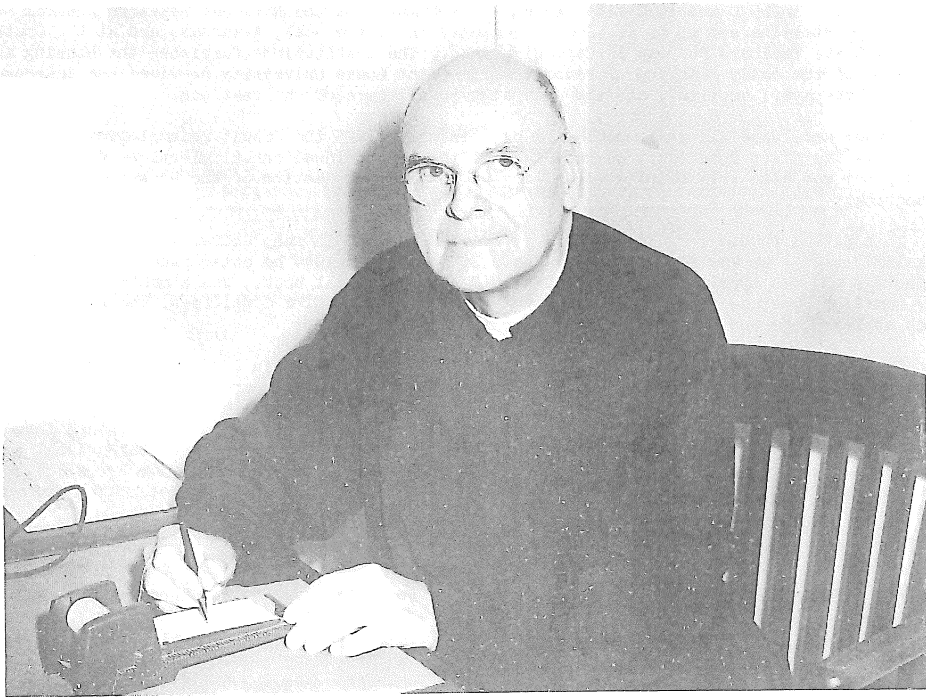
June 1956

No. 2

This memorial issue is dedicated to Reverend Dr. James B. Macelwane, S.J., a world renown scientist in the field of geophysics with particular emphasis in seismology. In preparing this tribute, the Editorial Committee of Earthquake Notes has obtained contributions from prominent students of Father Macelwane who knew him as an educator, leader in scientific organization (organizer of the Eastern Section), an exploration geophysicist, and a research director.

## SKETCH OF THE LIFE OF JAMES BERNARD MACELWANE, S. J.

The boyhood life of the late Reverend James Bernard Macelwane, S.J., was similar to that of many other boys who lived in the vicinity of Sandusky Bay, Ohio, off Lake Erie. Born on September 28, 1883, he was brought up with his four brothers and three sisters in a six-room one-story house on the northern shore of the Bay. Being the oldest boy in the family, he early learned to do the chores connected with the care of domestic animals, to help in the garden, on the farm, and in the fishing business.



Reverend Dr. James B. Macelwane, S. J. (1883-1956)

When the work at home was light, he with others in the neighborhood attended the public school to which he walked for a distance of about a mile and one-half. In the fall of 1901 he entered the freshman class of St. John's High School in Toledo, Ohio. By the end of the year he had not only completed the classwork of the freshmen and of the sophmores, but won the gold medal as the best student in his class.

He was nineteen years of age when he completed his junior year of high school. His thoughts now turned to the future. Uppermost in his mind was the career of a missionary. In August, 1903, he was admitted to the Buffalo Mission of the Jesuit Order. The novitiate of this Mission was in Cleveland, Ohio. Here, after two years, he took his vows as a religious and then entered upon a two-year program of studies in the humanities. He was particularly fond of Latin and Greek.

After teaching one year at the St. John's High School in Toledo, and after studying philosophy

and science for three years, he taught physics at Saint Louis University from 1912-1915. With the completion of several years of studies in theology, he was ordained to the priesthood in 1918.

Father Macelwane's first interest in seismology was aroused in 1909 when an 80 kilogram Wiechert seismograph was installed at Saint Louis University. In 1911 he as coauthor published an article entitled "Physics of the Seismograph." This was the first of his 133 articles which were to appear in various learned journals in his lifetime.

Because of his fine ability in the natural sciences, his superiors advised him to take up studies for the doctorate at the University of California in Berkeley. Here he took the Ph.D in 1923. Physics was his major, geology and mathematics constituted his minors. His dissertation was in seismology.

He stayed on at the University of California for two more years as Assistant Professor of Geology. During these two years he organized graduate studies in geophysics and had charge of the University seismographic stations at Berkeley and at Lick Observatory on Mount Wilson.

In 1925 he returned to Saint Louis University to be the first Director of the new Department of Geophysics. He remained the Director until his death.

Shortly after his return to Saint Louis he added to the facilities of the seismological observatory. In 1927 the seismic vault in the University Gymnasium was completed and equipped with Wood-Anderson seismographs. The following year the Florissant vault, located seventeen miles northwest of the University, was set in operation with three Galitzin-Wilip and two Wood-Anderson seismographs. In 1930 and 1938 with the aid of a grant from the National Research Council he had seismograph stations set up at St. John's Seminary in Little Rock, Arkansas, and at St. Southeast Missouri State Teachers College in Cape Girardeau. The institutions furnished the housing and took care of the daily changing of records while Saint Louis University provided the instruments, photographic paper, supplies, and the general over-all care of the stations.

Father Macelwane was instrumental in organizing in 1925 the Jesuit Seismological Association. Elected as its first President, he held this office by continual annual elections until his death. His support was also very helpful in setting up the Eastern Section of the Seismological Society of America.

In addition to his work in seismology, he was involved in many university appointments. From 1927 to 1933 he was Dean of the Graduate School and in 1944 he established the Institute of Technology and was appointed its first Dean. He wrote several books, was a member of the University Board of Trustees, served on many faculty and administrative committees, and found time to teach at least one and often two classes per semester.

His services were constantly sought outside the University. In 1947 he was appointed to the Research and Development Board of the Department of Defense. Two years later he became a member of the Scientific Advisory Board of the United States Air Force; in 1952 an appointment placed him on the Committee on Institutional Research Policy of the American Council on Education. President Eisenhower appointed him a member of the National Science Board of the National Science Foundation. He looked ahead with enthusiasm to the International Geophysical Year of 1957-1958; in this connection he was Chairman of the United States Technical Panel on Seismology and Gravity

His active membership in over twenty-five learned and professional societies brought him into official capacities in many of these organizations.

The excellence of his scholarly attainments is indicated by the many honors which came to him for his unusual research achievements in the field of seismology and geophysics in general. In 1948 the American Geophysical Union William Bowie Medal was bestowed on him. He was a member of the National Academy of Sciences, received four honorary degrees, and was given posthumously the American Institute of Mining and Metallurgical Engineers Jackling Award.

After he returned in 1925 from his four-year stay at the University of California, he remained until his death at Saint Louis University. His life in the Jesuit community was characterized by his friendly cheerfulness and simplicity. All knew and thought of him as the friendly "Father Mac" and only upon reflection were his colleagues and many friends aware of the fact that he was a scientist of great renown.

His many achievements were made possible by an incredible capacity for hard work, great patience, and ability to relax and not to worry about the most vexing problems. Although he worked until late hours of the night, he arose promptly at five o'clock in the morning. By eight he was already in his office deeply engrossed in the day's work. After lunch he read the newspaper. He kept himself well informed on local as well as national and international events and trends. Certain sections of the comic sheets were of delightful interest to him. However busy, he managed to converse for an hour or so with his university religious brethren assembled in the community room after dinner in the evening. Thereafter he returned to his private room for prayer and then to his office to work into the quiet hours of the night.

Until the year before his death his health was excellent. His endurance, whether in his office, in the research laboratory, or while geologizing in the Colorado Rockies, was remarkable. But a change came over him in the autumn of 1954. He appeared tired and the usual sprightliness of his step disappeared. General fatigue and elusive intestinal disturbances finally led the doctors to hospitalize him in November, 1955. An exploratory operation on December 19 revealed acute necrosis of the liver and subsequent evidence also showed serious impairment of the kidneys. While suffering little pain in his last illness, he impressed all by his patience and good humor during the many weeks of hospital inconveniences. Death came peacefully on February 15, 1956.--VICTOR J. BLUM, S.J.

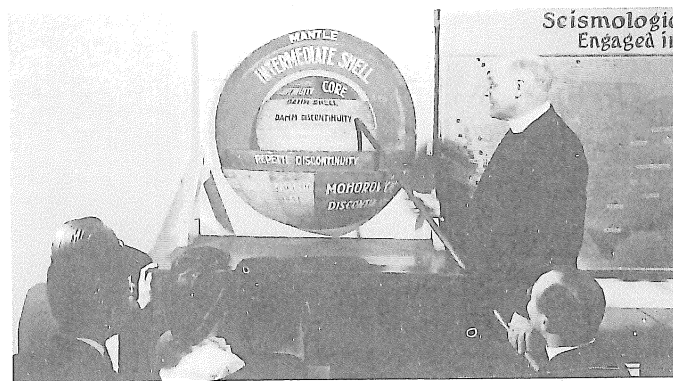
#### THE CONTRIBUTION OF FATHER MACELWANE TO THE FOUNDING OF THE EASTERN SECTION, SEISMOLOGICAL SOCIETY OF AMERICA

The more recent members of the Eastern Section of the Seismological Society of America have been reminded at various annual meetings during the past few years that Father Macelwane was one of those responsible for the formation of the Section. It now seems a fitting time to place on record some of the details of the organization of the Section, early in 1926.

The parent Society was founded in California in 1907, following the San Francisco earthquake of 1906. Most of what might be called "local" interest in earthquakes was confined to that section of the country. The seismological work in the East during the early part of the present century was confined to station recording and was carried on mostly by Father Tondorf of Georgetown, Father Macelwane of Saint Louis, Professor Woodworth of Harvard, Professor Hobbs of Ann Arbor, Dr. Klotz of Ottawa and the United States Government, at first through the Weather Bureau and later by the Coast and Geodetic Survey.

At the time of the founding of the parent Society, no provision was made for the formation of any Section. But during the early 1920's, the active seismologists in the East began to feel the need for some organization which would permit discussion and the correlation of activities. All meetings of the Society were held in California and, especially during those days, it was difficult or impossible for eastern members of the Society to attend.

It was not desirable that a separate Society be formed in the East. Efforts were made to secure an amendment to the Constitution of the Seismological Society of America to permit the formation of an Eastern Section. Father Macelwane, Captain (then Commander) Heck of the Coast Survey, and Dr. Day, Director of the Geophysical Laboratory of the Carnegie Institution of Washington were in the van of those pressing for such an amendment.



Father Macelwane lecturing on earth structure at St. Louis University.

In 1925, Dr. Bailey Willis was President of the Seismological Society of America and was known to be in sympathy with the proposed amendment. Nevertheless, nothing was done; action was postponed and delayed. Serious consideration was being given to the project of forming a separate society in the East.

In December, 1925, the Annual Meeting of the American Association for the Advancement of Science was held in Kansas City. It was very well attended. Heck, Father Macelwane, and Hodgson were present and spent a good deal of time discussing the possibilities of forming an Eastern Section. They returned to Saint Louis on January 2, 1926. Heck and Hodgson put up at the Melbourne Hotel, adjacent to Saint Louis University.

The next morning they met Father Macelwane on the street in front of the University. He was on his way to their hotel. His face was beaming as he produced a letter from President Willis authorizing the formation, pro tem, of an Eastern Section, subject to later authorization by the Directors of the Society. He stipulated that there must be three interested persons to undertake the organization.

The Eastern Section was promptly formed, there on Grand Boulevard, with Father Macelwane as Chairman, Hodgson as Vice-Chairman, and Heck as Secretary-Treasurer. The Vice-Chairman was to organize, compile, and distribute a Bibliographical Bulletin; the two other officers were to draft a Constitution and By-Laws and to secure members.

It was agreed that the membership should be restricted to those living east of the Mississippi, with an exception taking care of the metropolitan area of Saint Louis; and, in Canada, those living in Ontario or east thereof. Persons living beyond these limits might become associate members or subscribers but could not have a voice in the administration.

The next few months were busy ones for all three officers. The first Annual Meeting was held in Washington on May 1, 1926, the sessions being convened in the auditorium of the Carnegie Institution of Washington. The initial paper was given by President Bailey Willis, in which he announced that the necessary authorization for the organization of the Section was assured and was under way.

The officers, who had been acting in an interim capacity, were appointed for the coming year by the voice of the Meeting. The membership roll, at that time, showed 105 active and 19 associate members. The afternoon session registered an attendance of 50. It was arranged that the second annual meeting should be held at Cambridge.

At the Washington meeting, Father Macelwane presented a paper on the organization of the Jesuit Seismological Association (19 stations) by Father Odenbach in 1909, and its reorganization in 1925 with 11 stations, the central station being at Saint Louis.

Father Macelwane presided at the second Annual Meeting, held at Cambridge, May 4-5, 1927. The slate of officers was reappointed. The third Annual Meeting was planned for the University of Virginia, at Charlottesville. The active membership at the time of the Cambridge meeting was 177. The number of associate members at that time is not known.

The third Annual Meeting was duly held at Charlottesville, April 1-3, 1928. Father Macelwane had, in the meantime, resigned as Chairman of the Eastern Section, having been appointed President of the Seismological Society of America. The active membership was now 186. The meetings, continued for three days counting excursions, were well attended.

It may safely be said that Father Macelwane, more than any other one man, was the prime mover in founding the Eastern Section. He enjoyed the counsel of Commander Heck and Dr. Day. In California he was well and favorably known. He had taken his doctorate degree at the University of California only a few years before. He was a good friend of Bailey Willis who held the strategic position of President of the Seismological Society. Father Macelwane and President Willis conspired to find a way to permit the founding of the Eastern Section and they pushed it through. Father Macelwane contributed much to the subsequent work of organization. He continued his interest, his influence, and his assistance throughout the years. And, with him, he brought the widespread and active cooperation of the Jesuit Seismological Association.--ERNEST A. HODGSON

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#### FATHER MACELWANE AND THE JESUIT SEISMOLOGICAL ASSOCIATION

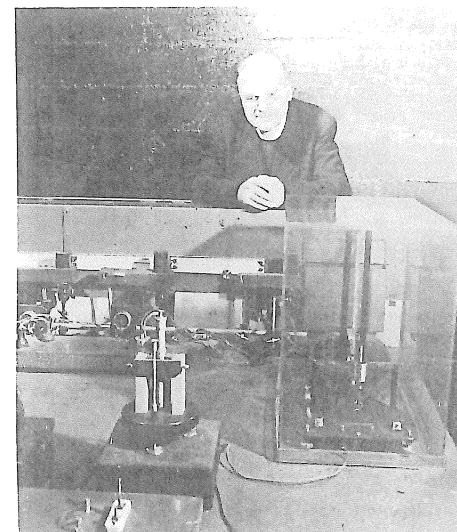
The Jesuit Seismological Service was founded by the Reverend Frederick L. Odenbach, S.J., when he was director of the Angelo Secchi Observatory at St. Ignatius College (now John Carroll University) in 1911. Father Odenbach's work continued for about a decade; but as the Jesuit fathers whom he had interested in operating the stations grew older and replacements were not provided, the activity of the organization lapsed. Father Macelwane, when he returned from his doctorate studies at the University of California, devoted himself immediately to reviving the interest of the Jesuits in seismology. He called the revised group the Jesuit Seismological Association. In 1925, the JSA came back to life at Loyola University in Chicago.

Father Macelwane was quick to see that interest in the organization could only be kept alive if young men were constantly trained to succeed the fathers who were currently operating the stations. He insisted with the Jesuit Superiors that men be set aside for this work. He devoted a great deal of time and energy to training these men personally. He himself led geologic field parties whose personnel entirely consisted of Jesuits to Canon City, Colorado, in 1934, 1937, 1941, and 1943. On these trips he drew upon his vast knowledge of the geology of the western states. He personally supervised the geological mapping which was done. He conducted classes in the evening around a gasoline lantern. He was guide, teacher, religious superior, and man-about-the-tent.

After the formal weeks of classes, he would direct two or three week excursions to the chief points of geological interest in the West--Bryce and Zion, Grand Canyon National Park, Great Salt Lake, the Black Hills, and the Badlands. He derived great pleasure from tracing the Dakota sandstone all the way from Canon City to Omaha, Nebraska.

In 1941, it was the writer's pleasure to be a member of one of these geological field parties. At times Father Macelwane's health was such that he found it extremely difficult to do the rugged climbing which was expected. Yet, he made it a point to carry more than his share of the work around the camp as well as the instructional duties.

He knew, too, that the individual station directors would need advice and encouragement. Accordingly, he arranged to visit each station in person at least every other year. These visits were most helpful to the individual directors. He kept them informed as to the latest equipment, commented upon the latest developments of the station, and encouraged the development of seismological research.



Father Macelwane inspecting a seismograph at St. Louis University.

As a tribute to his work with the Jesuit Seismological Association, John Carroll University presented a Golden Anniversary Symposium on October 18, 1954. This symposium has been reported in previous issues of Earthquake Notes.

As President of the Jesuit Seismological Association, Father Macelwane proved that the best administrator is one who has experienced the problems of those whom he directs. He had an un-failing understanding of the difficulties encountered in operating a seismological observatory on a limited budget, often hemmed in by a tight schedule of teaching.

His chief contribution to the JSA was his inspiring leadership. Each member knew that Father Macelwane worked harder and made greater sacrifices than anyone else. He was a man who lead rather than directed his associates. For this talent, his memory will be in perpetual benediction in the Jesuit Seismological Association.--HENRY F. BIRKENHAUER, S.J.

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JAMES B. MACELWANE, S.J., SCHOLAR

It was my privilege and good fortune to be associated with Father Macelwane at Saint Louis University for almost twenty years. There were many significant aspects to the professional career of this man. Who can select the most significant? How can one measure the direct and indirect accomplishments during the many years of his wide endeavors, for his chosen career was in scholarship, his province science, his field geophysics, and his specialty seismology?

His direct contributions to seismological research are recorded in the more than 133 manuscripts which he published. Some of these manuscripts are on specific detailed subjects, such as "A Study of the Relation Between the Periods of Elastic Waves and the Distance Travelled by Them, Based upon the Seismographic Records of the California Earthquake, January 31, 1922," (Bull. Seism. Soc. Am. 13:13-69, 1923). However, throughout his writings, in his lectures, and discussions there appears the thought:

The mere accumulation of facts in any field does not constitute a science. Man has been defined with some degree of truth as an animal who asks 'Why?'. He is not satisfied with mere observation. He wants to know the causes of things. (Macelwane, J. B., "So This Is Science!" Proceedings of the Missouri Academy of Science, vol. 4, pp. 87-92, 1939.)

Thus some of his manuscripts contained careful appraisals of the trends and spirit of the science of seismology:

In fact, there has been in recent years a growing tendency to reexamine all the accepted postulates underlying each of the conclusions derived from the mathematical theory of seismology. This healthy questioning of accepted theory has been directed not only toward a more detailed analysis of the effect of heterogeneity, of imperfect elasticity, and of discontinuities, but also toward a better understanding of the character of seismic motion itself and particularly of the nature of actual seismic waves and of the response of seismographic systems to these waves. ("Modern Trends in Seismological Research," Trans. Amer. Geoph. Union, 17th Annual Meeting, pp. 23-25, 1936.)



Father Macelwane and students during a seismology seminar.

On occasion, when his discussion was concerned with critical evaluation, he would recall that "What we are really interested in here is the scientific spirit, which is an attitude of mind. As William James expressed it: 'I have to forge every sentence in the teeth of irreducible and stubborn facts.'" (Moulton, Harold G., "Science and Society," Science, 87:175, February 25, 1938.) He used this criterion objectively on his own work as well as on the work of others:

In the present state of our knowledge it is impossible to say with certainty what is the state of matter in the core of the earth and whether shear waves are propagated in the outer core, the inner core, or neither. Macelwane, Bastings, Imamura and others have presented evidence in favor of shear waves in the core, but it does not seem conclusive. (Chapter X, Internal Constitution of the Earth, page 290, 1939.)

He not only analyzed the state of knowledge in seismology in a highly technical treatise (Macelwane, J. B., Geodynamics (Part I of Theoretical Seismology by Macelwane and Schon), New York, John Wiley & Sons, 1936), but in a more popular way (Macelwane, J. B., When the Earth Quakes, Bruce Publishing Co., Milwaukee, Wis., 288 pages, 1947). He possessed the rare ability of communicating the ideas of his profession to the layman with understanding and was always eager to do so.

During the years of organization and evolution of the Institute of Technology of Saint Louis University, a great amount of his administrative ability was devoted to the difficult problems of professional curricula in geophysics, geology, and meteorology. He shared the results of some of these efforts in committee discussions and published articles in the journals of several professional organizations. He was a strong advocate of the field of geophysical engineering.

The geophysical engineer is characterized by his ability to apply not only general scientific principles but specifically the geophysical sciences to the design, construction, and calibration of suitable geophysical equipment; to plan and execute discriminating application of these sciences and their instrumentation to problems of ex-

ploration for commercially valuable subsurface deposits of petroleum, ores, and other minerals; to the location of water supplies; to the delimitation and characterization of bed rock and overburden; and to the measurement and analysis of industrial vibrations and their structural effects. He is characterized by his ability to forecast the performance of geophysical instruments and procedures under the limitations imposed by their design and the circumstances of their application; to estimate with accuracy the cost of the operation and to adjust the procedure to the justifiable outlay in view of immediate or long range returns; and to do all this in full consideration of human relationships and of safety to life and property. (Macelwane, J. B., "What Differentiates the Geophysical Engineer," Mining Engineering, vol. VI, No. 4, pp. 390-392, April, 1954.)

Both in planning and in action there were facets of his personality which seemed to catalyze his professional efforts.

He had the ability to inspire those with whom he came in contact. This he achieved by showing in his relations with people a sense of duty, responsibility, willingness, humility, and especially a deep appreciation of the feelings of those about him. His natural enthusiasm and sincerity were a strong influence on all he met.

As a teacher in the classroom and in the field he helped students put forth their best efforts.

As a research colleague and director he would act so as to inspire professional goals.

As a member of many professional organizations and committees, his willingness to undertake and complete specific tasks impressed his associates. His activity and interest in the Eastern Section is one example of this.

His sense of humor helped him through vexing situations and served to relieve any artificial seriousness that might tend to obscure the real point of a problem.

I know of no better summary of Father Macelwane's approach to his scientific tasks than his own words which he used in concluding his retiring Presidential Address to the Missouri Academy of Science in 1939:

We have reached a critical period when as never before we need clear thinking, a clear distinction between fact and hypothesis, between a postulate which is assumed because it seems plausible and a principle which is immediately evident because of the perfectly obvious connection between the terms of the judgment, between the particular subject and its predicate, thus necessitating the judgment. When an argument for the reality of evolution as understood in one sense is made to do service for evolution in a totally different sense; or when the necessary abstraction by one science from the subject matter of another science, or from the ultimate underlying causes, is twisted into a denial or into a proof of non-existence of those facts or causes, then we are dealing either with intellectual dishonesty or with muddled thinking. When a whole realm of truths is positively excluded a priori from consideration we are not dealing with science at all, but with agnostic prejudice! A really scientific spirit is a passionate love for truth whatever its source and whithersoever it leads. Opinions and prejudices are only encumbrances of the ground that must be cleared away to make room for the solid foundation of truth. Hypotheses and working theories are but the scaffolding with which the grand edifice of truth is erected.

All the particular sciences and a sound, objective philosophy must work together to rivet the frame and rear the lofty towers of truth whole and entire. There has never been, nor can there be, any real conflict between two sciences nor between true science and true religion. Any supposed or seeming conflict has arisen from misunderstanding and misinterpretation of the facts or from the pseudo-philosophical prepossessions of the interpreters. --ROSS R. HEINRICH

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REVEREND JAMES B. MACELWANE, S.J.

For the past twenty-odd years I have had the privilege to be associated in one way or another with Reverend James B. Macelwane or Father Mac, as he was known to those who worked with him. Much has already been said and more will be said about the various phases of Father Macelwane's career as a scientist, as a teacher, and as a priest. Factual superlatives by the dozen will be used to describe his many abilities and accomplishments.

However, when I think of Father Macelwane, these are not the things which come to mind. Rather, I think of a pleasant, gracious person, one who was interested in what I thought and did and whose

time and energy were available to me almost at will. These attributes endeared Father Macelwane to all who knew him. These, combined with his many abilities and leavened by a humility such as few men possess, were integrated into a truly unique human personality.

My first association came as an undergraduate student in Geology taking a course in "Earthquakes." Father Macelwane's scholarly approach to knowledge was soon evident. We began with "The California Earthquake of April 18, 1906--Report of the State Earthquake Investigation Commission." To an undergraduate student, this voluminous report could well have been made into a two-semester course. It was, however, subject matter for our first report, and others followed. As a teacher, Father Macelwane aroused in the student a genuine desire to learn.

With the beginning of my graduate work, I assumed the duties of an assistant in what was then the Department of Geophysics at St. Louis University. Here again Father Macelwane's zeal and attention to detail became apparent. My orientation into the problems of station operation was given his personal attention. The station in the Northwest corner of the University Gymnasium was to be my charge for the next year or so. My initial experience here under Father Macelwane's direction was a memorable one. He introduced me to the mechanics of changing records, adjusting and trimming the seismographs, clock operation and radio time signals, operation of the station humidifier and dozens of other details too numerous to mention. Next came the analysis and interpretation of seismograms. To the beginner, a seismogram is rather mysterious and not too intelligible. Problems arose quickly, giving rise to numerous questions. Father Macelwane was the main line of defense, and always he was available and ready to assist.

At this time Father Macelwane was also conducting a program of vibration measurements whose inception had been a few years earlier. The aim of the program was an investigation of the nature of vibrations produced primarily by quarry blasting, but not limited to blasting alone. The limestone and shale quarries in and around the St. Louis area supply the basic raw materials for the local cement industry. Consequently, quarry blasting constituted the largest single source of vibrations and the program was referred to as "blasting."

Many factors were recognized and subjected to analysis, and occasionally a workable solution came from the mass of data. In these days there was yet no Bulletin 442 of the United States Bureau of Mines, "Seismic Effects of Quarry Blasting," and other later works by other investigators on the same subject. The question of acceleration and/or displacement was discussed many times as also was the question of velocity. The duration of vibration at any one time and the long-term effects or fatigue were mulled over. Some of these are serious problems yet today, and their answers seem almost as elusive now as they did then.

Despite the complex nature of the apparently simple problem, Father Macelwane made steady progress and rendered valuable advice and service to the quarry industry. Blasting programs were adjusted both as to size and technique of operation. For example, one operator changed from an initial practice of bi-monthly and tri-monthly shooting to a program of weekly shooting. In the original program, the quantity of explosive was measured in tens of thousands of pounds, and it was customary to send out field agents to placate irate householders by paying for damages sustained as a result of the blasting, both real and imaginary. At this time the quarry operator generally felt that it was easier to pay off. Under Father Macelwane's direction, the shooting technique was changed to one calling for more frequent shooting with smaller total charges of explosive. The over-all efficiency of the program was greatly improved. The volume of rock broken was increased, fragmentation was better, and secondary blasting was reduced.

These advantages were achieved by Father Macelwane using the seismograph as the watch dog of the operation. More than once people of less insight into the problem questioned the use of the seismograph, pointing out that the quantity of rock knocked down seemed, in the final analysis, to be the logical answer. As in many complex scientific problems, simple logic was not sufficient because of the many variables involved. Father Macelwane was seeking to reduce the undesirable vibration to a minimum level on the thesis that energy used in vibration could not be used to break rock, and energy used to break rock could not be used in vibration. The seismograph pointed the finger at the desirable technique delineating those shots which resulted in a low level of vibration.

Despite these significant advances, Father Macelwane pointed out that many factors such as the geological condition are not only highly variable, but beyond control. This variability and lack of control necessarily will result in variations from shot to shot, place to place, and time to time.

Instrumentations used by Father Macelwane were adaptations of early mechanical field seismographs. The most successful and useful of these are the Taylor-Macelwane seismograph which went through many modifications, but withal was the workhorse instrument of Father Macelwane's early vibration work. Later instruments were developed jointly by Father Macelwane and the Sprengnether Instrument Company of St. Louis, Missouri.

Aside from his many scientific contributions, probably Father Macelwane's greatest service to the quarry industry was acquainting and impressing the operators with the significant service that the seismograph is able to render them.--EDWARD J. WALTER

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