

## **Francisco Munizaga Villavicencio (1945-2020): the developer of geochronology and isotope geology in Chile**

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Francisco Munizaga graduated as a geologist from Universidad de Chile in 1968. He led a life-long continuous academic career at the Geology Department, Faculty of Physical and Mathematical Sciences, Universidad de Chile, Santiago. He was promoted to Full Professor (Profesor Titular), the highest academic rank at that University. This prolonged and brilliant career was built upon his exceptional ability as a scientist, work ethics and dedication to undergraduate and graduate teaching, research and international collaboration; Munizaga (Pancho or Muni to his friends) excelled in all fronts.

His father was an academic who obtained the National Award in Education, so Francisco was familiar with the challenging attributes of academic life in Chile. With his wife, Marili Lois, a dentist, they raised two children, Mali and Francisco. He cherished his close relationship with daughter, son, and grandchildren.

His main teaching activity from the beginning of his career was the undergraduate course in Crystallography and Mineralogy, which he refined and modernized, developing through time a fine collection of crystallographic models and mineral samples for teaching.

In the early seventies he introduced the emerging discipline of Geochronology into the undergraduate



curriculum. This novel initiative was initiated after he was chosen by the Geology Department to spend several weeks at the *Centro de Pesquisas Geocronológicas* (CPGEO) of the Instituto de Geociencias, Sao Paulo University, Brazil. He was sponsored by the Organization of American States, with the mandate of learning the K-Ar dating method and apply it to Chilean samples under the guidance of Professor Umberto Cordani and his team. This signified a major shift in his professional life, as he, from then on became a pioneer developing and practicing geochronology as never before in Chile. Munizaga's effort and initiative led to extensive application of this speciality in the country and in South America.

In 1975, together with professors Umberto Cordani (CPGEO, Instituto de Geociencias, Sao Paulo University, Brasil) and Enrique Linares (University of Buenos Aires, Argentina) he became a co-leader of UNESCO's IGCP (International Geological Correlation Programme) Project 120 "Magmatic Evolution of the Andes". This Project was a great success, being renewed and funded for a decade; they ran meetings every year in different cities around South America and brought researchers together to collaborate in the big task of dating rocks and tectonic events in the Andes. Project 120 attracted scientists from USA, Canada, France, UK, Germany to mention a few, established Muni as a leader in the field, and became the cradle of very remarkable and fruitful scientific collaboration. Munizaga and researchers from different South American countries became frequent guests of CPGEO, where various other geochronological techniques were available.

This international scientific collaboration resulted in important scientific outcomes and fruitful personal bonds among the participants. Munizaga played a prominent role in awakening the interest in the andean geology of then-young researchers at CPGEO. Through his informal lectures, as was his style, he motivated the young group from São Paulo to become interested in the study of the mountain ranges that, over the following long years, enabled countless cooperation that lasted throughout Muni's entire scientific life.

Munizaga was the only one of the three leaders of IGCP Project 120 who did not lead his own geochronology laboratory, and he thus made a big effort to develop one at the Instituto de Investigaciones Geológicas (IIG), the Geological Survey of Chile, SERNAGEOMIN from 1984 on. His contacts and good relationships with Brazilian and British researchers, allowed Koji Kawashita of CPGEO and later Norman Snelling from BGS, UK, to stay in Santiago supporting the development of K-Ar and Ar/Ar laboratories. Robert Drake from Stanford University was also a collaborator in research along Chile with the K-Ar methodology.

Conscious of the limitations of Universidad de Chile to sustain a geochronological laboratory in the 80's and 90's, he contacted and collaborated with foreign scientists who applied new methodologies, as the Re-Os system in the sulphides of copper deposits with Joaquin Ruiz of University of Arizona. He was a main participant in the Conicyt-Conicet

(Con-Con) research Projects between Universidad de Chile and Universidad de la Plata, which addressed the geochronology and tectonics of wide areas in the north-central Andes and Patagonia. During the 21<sup>st</sup> century, he continued his excellent relationship with CPGEO, which culminated with the U-Pb zircon dating of many Chilean samples by the SHRIMP and LA-ICP-MS methods.

Progressively, he was attracted by studying the geochronology and isotope geology of some of the main mineral deposits in Chile, as he was frequently in demand by the personnel involved in the mining operations to generate such information. He thus generated and participated in national and international projects related to mineralized areas producing relevant information on very different isotopic systems in mineral deposits.

In the 1990s Muni was co-leader of IGCP UNESCO Project # 342 "Age and Isotopes of South American Ores, with Colombo Tassinari of University of Sao Paulo, and Marcos Zentilli, Dalhousie University, Halifax, Canada. They organized various meetings and field trips in Venezuela, Brazil, and Chile. The project was very successful and led to numerous publications in journals and congresses.

Munizaga's scientific production includes an important number of research papers in a variety of world class journals, as well as contributions to congresses and meetings. He was part of the organizing committees in numerous scientific meetings at national and international levels.

His open and friendly personality opened numerous avenues for collaboration for him and people around him -including the authors of this text- in an unrivaled way of positive relationships where the best human values were practiced. Munizaga was very strict in practising the scientific method, and refused to be considered the top figure in his research groups, nor in the diverse baby football teams in which he enthusiastically participated.

His colleagues and friends recall that Pancho was in demand for his mature, calm, thoughtful advice. He listened with undivided attention and always provided his wise opinion. His students remember him as a devoted, effective teacher and mentor.

As an homage to his human virtues, we include below a paragraph written by one of us (CT) which plays on the personal relationship of decades with FM.

"I met Prof. Francisco Munizaga in the second half of the 70's at the Center for Geochronological

Research at the University of São Paulo, when I was starting my career in geochronology. Pancho, as he was known, soon became my partner in research and my friend in personal life. Always working in the Chilean Andes, we have done several geochronological works on Andean magmatism. But in the early 1990s, at Pancho's suggestion, based on his great vision of the future, we changed our joint research line to the application of geochronology and isotope geochemistry to metallogenesis and mineral exploration, an area we developed together until his retirement.

In this area we had the opportunity to do several field works together in several Cu and Au deposits in Chile, always accompanied by a good table and the Chilean wines that he appreciated so much. But these works also made it possible for Pancho to come several times to São Paulo to develop laboratory works. At this point I allow myself to leave the research activities aside to talk about my personal friendship with Pancho Munizaga. On the trips he made to São Paulo we also took the opportunity to do what he liked best here, which was to enjoy a good barbecue with a good caipirinha, a traditional Brazilian drink based on sugar cane spirit (cachaça) and lemon.

Knowing my great passion for Chilean empanadas and wine, Pancho always brought in his luggage about one or two dozen of these empanadas and several bottles of wine when he came to São Paulo,

which allowed me to remember the good times I had in Chile with him. One of his visits to São Paulo that I have fondly cherished in my memory was in 2014, when he came to watch the world soccer championship, which was another of his passions, together with his son and grandchildren. They stayed at my house and we had the opportunity to watch the match between Chile and Holland in the stadium and also to visit the soccer museum of São Paulo, where Pancho was moved by the images of the 1962 World Cup.

Within all the activities, whether professional or personal, that I had with Pancho Munizaga I would like to highlight the last trip I had the opportunity to make with him, fulfilling his desire to visit Portugal and Spain (Basque country, place of origin of his family), which was in June/July 2019, when we enjoyed several memorable moments, such as tasting the famous Bairrada suckling pigs in Portugal, the cochinitillo from El Sobriño de Botín restaurant in Madrid and tasting the cider from the Asturias area in Spain. It is with these images that I must forever remember my friend Pancho Munizaga.”

I believe that all of the coauthors of this obituary, and many other colleagues, had similar fraternal experiences with Francisco Munizaga, which constitute a most valuable heritage for the geological community, which we would like to disseminate through this brief account of his life.

Santiago, January 2022