

Note: This speech was meant for geologists in Chile, the majority much younger than me, who have never met me and who only may have read my publications. I needed to reassure them that I still am a Chileno at heart.

My words of thanks (via Zoom) after receiving the Professor Juan Brüggen Medal of the College of Geologists of Chile on August 29, 2023, during FEXMIN 2023, Santiago*

Marcos Zentilli van Kilsdonk

*Kindly translated from Spanish by my former Dalhousie BSc student Thomas Mulja, now PhD.



Thank you very much, Patricia Narváez, Directors and colleagues of the College of Geologists, organizers of FEXMIN, and those who secretly proposed me for the Nobel Prize of Chilean geologists. Congratulations also to my colleague Mario Alfaro on his well-deserved medal. I am very proud that I have been considered for the award. As an adopted Chilean I thought I would not qualify because, due to life circumstances, I have more than half century outside Chile, but my heart remained stuck in its mountains. I never stopped feeling Chilean.

I grew up very much in the wilderness in the mountains of El Arrayán in Las Condes (**Fig. 1**) near Santiago, skiing in developing resorts Farellones and Lagunillas, often in places without ski lifts and using wooden skis, tied with long leather straps, the "French binding" of those times, before metal bindings were affordable.



I was planning to study civil engineering (my father was an architect), but in 1958, I enrolled in the recently established School of Geology without knowing what geology was (**Fig. 2**). It was because a student who had done a summer internship with the oil company ENAP in Magallanes (Patagonia) told my brother and me that

Salida a Terreno Escuela de Geología 1958



geologists were paid to hike and camp in the mountains; I liked that idea much more than being stuck in an office. And that is how it worked out: until a few years ago my work included hiking in the mountains and sleeping in tents even in the Arctic (**Fig. 3**. Camp organized by my daughter Veronica while a teacher at Arctic College, Nunavut).

Pond Inlet, Baffin Island, Ártico Canadiense (Latitud 73°N)



Acampando sobre hielo oceanico, junio 1995

First, (Fig 4.) I share the award with my colleagues, students, field assistants (here the late Roberto Araya, who helped me during the thesis for my first Geology degree, in the manganese mines of Fragua, Corral Quemado, near Ovale), co-authors, colleagues and professors who supported me throughout the career, plus the usually invisible and dedicated secretaries and the many drivers and porters, who took care of us, repaired punctured tires in the field (once 6 times in 2 days in the high Maricunga mountain range).



I must also thank Dalhousie University, who hired me in 1972 for one year. But I was treated too well and stayed, retiring as professor emeritus in 2005; remarkably, I still get a small office and their services. The University has even inaugurated a graduate scholarship in my name (giving.dal.ca/zentilli).

Especially (Fig. 5) I share this medal with my partner and wife Armgard Raczynski von Oppen, sister of my classmate and fellow geologist, the late Andreas Raczynski, through whom I met her (thank you, School of Geology), and with whom we are celebrating 60 years of marriage; I would not be celebrating this award today



without her patience and unconditional support (and that of our three daughters) during my repeated long periods in the field and extended hours in the laboratory and the office. It must have been very tiring to have a husband or a father geologist.

After a couple of geology classes with the founder of the Geology School, Don Humberto Fuenzalida Villegas (**Fig. 6**), I simply became geo-fanatic, persistent and incurable. In the photo in Venice in 1964, when I was on a DAAD scholarship in Munich, Don Humberto came to give a talk at the university, and he said: "I would like to see Venice before I die"; so we rushed him in a battered VW bug through the Alps (him paying for gas and lodging). But he didn't tell us that he had terminal cancer (note his lit cigarette in hand); he passed away a year later before I returned to Chile; I never saw him again. Don Humberto was an extraordinary scientist and human being.



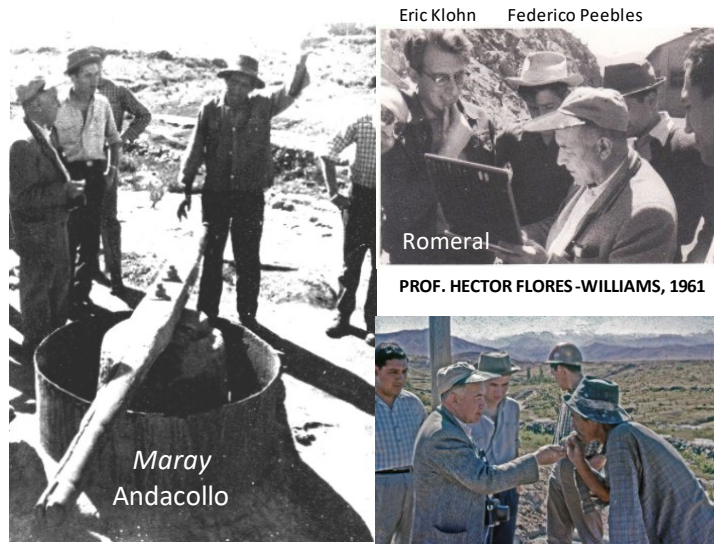
In those days we came to class in winter wearing a suit and tie (note the polished shoes) and with coat and scarf (**Fig. 7**), because the freezing building at Plaza Ercilla 803 had no funds for heating; Don Humberto warmed his hands over a small kerosene stove to write on the chalkboard. Painful for me is that not one of my classmates in this photo is alive to share this ceremony; three have recently left us. I thank my teachers and teaching assistants of those times, including the late Beatriz Levi (who received the Brügggen medal) and some

1er Año Escuela de Geología 1958



foreigners who educated us on the strict mapping routines used in the United States Geological Survey, and taught us about structural geology, hydrogeology, exploration geochemistry.

The most important thing for me is that a **community** was created, especially thanks to the many field trips. With Prof. Hector Flores-Williams, a renowned mining engineer (**Fig. 8**) we visited innumerable mines, but strangely, they never took us to see the porphyries, from which I graduated in 1963 knowing almost nothing. Most of us geology students were working part-time and doing summer internships in the brand-new Geological Research Institute (IIG), across from the Municipal Theater in downtown Santiago. The IIG was an organization of CORFO, and precursor of SERNAGEOMIN. Everyone in the community of geologists knew what the others were doing.



Just graduated in December 1963, I left with a DAAD scholarship from the German government and studied mineral deposits at the Ludwig Maximilian University of Munich with famous Prof. Albert Maucher, including the complex mineralogy of the only tin deposit that exists in Chile, in the district of Tignamar, in the Arica highlands. If the reviewers approve it, we will be publishing it later, 60 years later! When I returned in 1965, the IIG transferred me to Copiapó in the Atacama Desert (**Fig. 9**), to evaluate for ENAMI the mining potential of the Cordillera to the border with Argentina; my bosses were the ENAMI engineer the late Mario Serrano



and the distinguished IIG geologist, the late Francisco Ortiz (who also received the Brüggen medal).

In those times the age of igneous rocks (**Fig. 10**) was not clearly known, and to understand the geology I needed to date them with modern methods. That's how it was in 1968 I arrived at Queen's University in Canada where (thanks to an NSERC Scholarship), along with a group of graduate students, we dated rocks by

Copiapó



the potassium argon method and studied ores and rocks, in the laboratories of professors Drs. Alan Clark and the late Edward Farrar, and thus we confirmed the systematic eastward migration of the volcanic/magmatic front, from the coast in the Jurassic to the border with Argentina in the Miocene, its relationship with different types of mineral deposits and with the then-emerging concept of plate tectonics. They convinced me to do a doctorate, which I managed to finish only in 1974.

My father told me that in life it was important to have a "multiplier effect" positive in others, like the waves that expand in the water. I never imagined that he would end up as a college professor (**Fig. 11**). But the events of life decide for us. I have had the privilege of directing more than 20 doctoral theses (Ph.D.), more than 20 masters (M.Sc.) and 60 bachelor's theses (B.Sc. Honours), many by Chilean students on subjects based

Tesis de Doctorado y Magister por chilenos o de temas chilenos

- 1979 **Carlos E. Ulriksen** **M.Sc.** Geocronología Taltal...
- 1990 **Victor Maksaev** **Ph.D.** Metalogénesis Pórfidos
- 1999 **José Cembrano** **Ph.D.** Deformación Liquiñe Ofqui
- 2002 **Ricardo Boric** **M.Sc.** El Soldado...

- 1997 **Darryl D. Lindsay** **Ph.D.** Estructura Chuqui
- 1997 **Meghan Lewis** **M.Sc.** Covelina Chuqui
- 1998 **Nicholas Wilson** **Ph.D.** El Soldado
- 2003 **Lexie Arnott** **Ph.D.** Alteración Chuqui

Darryl Lindsay en Chuqui

on the geology of Chile. Eleven have become university professors and my former students have contributed more than me to the geology of Chile.

My parents instilled in me that you shouldn't brag about your own accomplishments, but it took me about 10 years to realize that in the Anglo-Saxon world this humble attitude does not give any dividends. I always insisted on the alphabetical order of authorship in publications, Zentilli at the end; but not anymore! At the ceremony for my retirement, when I complained that they praised me excessively, an esteemed colleague told me: "Marcos, accept these praising words now, next time it will be for your funeral, and you won't be around to hear them". I will tell you a couple of curiosities that I am proud as a roaming Chilean geologist, and if they are not that scientifically important at least they may interest you:

- 1) In 1978 I was involved in an international project to drill 2 kilometers deep into the oceanic crust in Iceland. One Sunday I was alone describing drillcore, something in which I had more experience than the others, while the project managers and the rest of the technical team went sightseeing, a young law student in internship as a journalist for the newspaper Visir (Fig. 10 note my Chile patch on my sleeve). She interviewed me about the project and took a lot of photos. This is how, purely by chance, I became, I believe, the first Chilean geologist to appear on the front page of a European newspaper. The young lawyer/journalist Berglind Asgeirsdottir became ambassador in Russia until 2020, and we still keep in touch.



- 2) We all know that molten magma rises from deep in the crust or mantle. But during mapping of the fjords with my Icelandic student Dr. Johann Helgason, we showed that major basaltic dike swarms in the Miocene of Iceland (Fig. 11) moved laterally (horizontally) for tens of kilometers.

FIELD CHARACTERISTICS OF LATERALLY EMPLACED DIKES: ANATOMY OF AN EXHUMED MIOCENE DIKE SWARM IN REYDARFJORDUR, EASTERN ICELAND

Tectonophysics, 115 (1985) 247-274 HELGASON & ZENTILLI

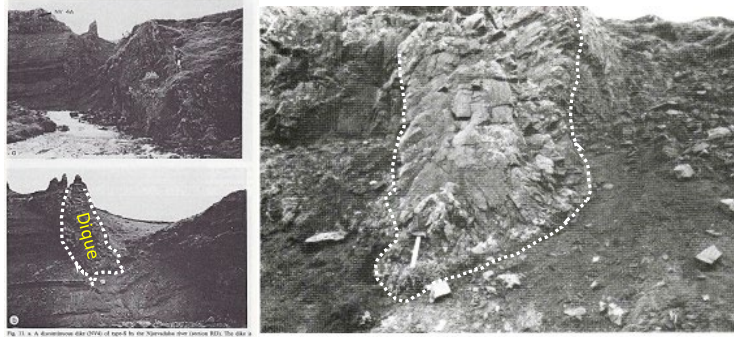


Fig. 11. A. A continuous dike (Dike 1) of type 1 (see Introduction for further details). The dike is exposed as 40 m thick outcrop (Helgason and Zentilli, 1985). It is noteworthy that the two vertical dikes exposed with about 2 m thick, are separated laterally by about 2 m and connected by a thin dike, which is not shown. The horizontal dike also has a similar width as connecting the two dikes. Inset with the same scale as the main image shows the dike in the upper part of the outcrop. Helgason and Zentilli (1985) also show the dike in the lower part of the outcrop. Helgason and Zentilli (1985) also show the dike in the lower part of the outcrop. Helgason and Zentilli (1985) also show the dike in the lower part of the outcrop.

Fig. 12. Type-S discontinuous (unit NV5, dike area J). The dike terminates about 2 m below the lava-sedimentary interface. In this case the vertical dike is completely cut off at the base. Therefore horizontal as opposed to vertical intrusion more likely explains the mode of dike emplacement.

Diques basálticos que terminan hacia abajo

Fig. 11. Basalt dikes terminating downward, could only have moved laterally.

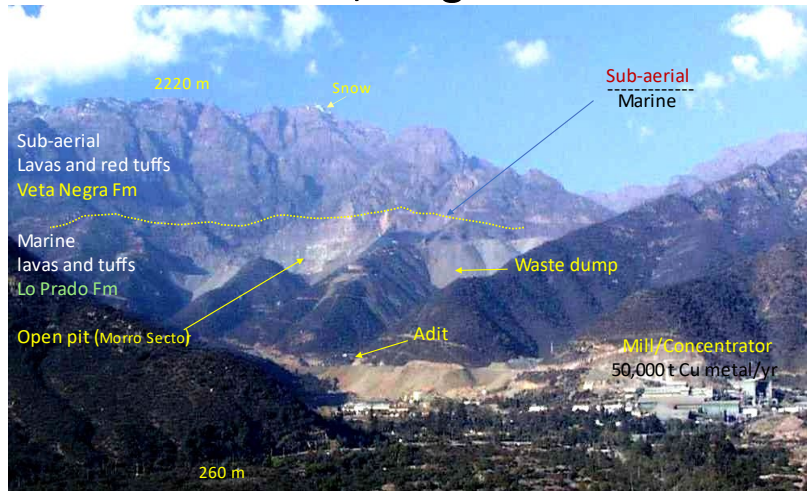
- 3) We know that icebergs float in the sea (Fig. 12), and only 10% is above the surface of the water. But it happens that with climate change sometimes they are loaded with rocks much denser than ice, and in that case, they sink partially and totally and are not detected on the radar. That is how it was during a foggy night in the Nares Strait between Northern Greenland and Ellesmere Island, Nunavut, when Canada's largest icebreaker (CCGS Louis Saint Laurent) collided violently with an almost totally submerged iceberg; it could have been disastrous, but fortunately we were going slowly, and only several computers fell although well secured to the benches. (Fig. 13) Who was the Chilean geologist who volunteered to study the rocks and fossils of the iceberg? Fossils and hydrocarbon maturation allowed us to indicate that the rock-loaded iceberg came out of the giant Peterman Glacier, northernmost Greenland, shortly after an unusual torrential rain that produced large landslides in the fjord margins and the expulsion of large barely floating (relatively flat) ice masses.



Zentilli, M, Harrison, J.C. & Crealock, J. (2006) *ICAM IV Proceedings*

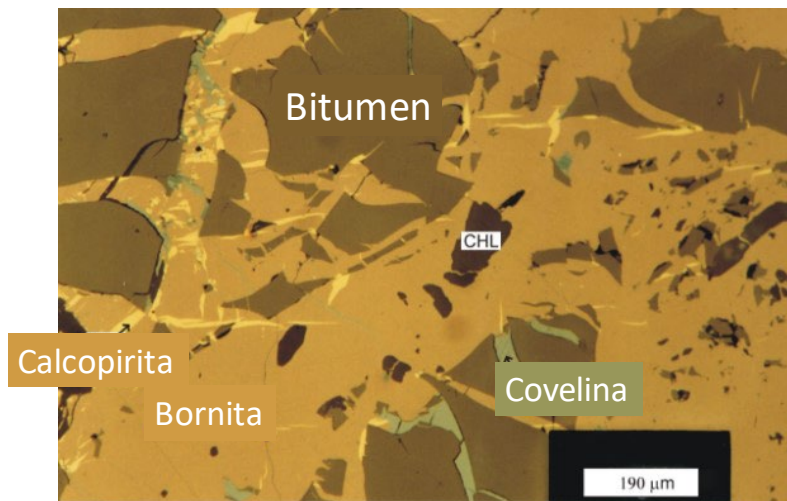
- 4) Manto-type copper deposits in Chile follow porphyry in importance. (Fig.14). With the late Prof. Francisco Munizaga and Dalhousie students Nick Wilson, Ph.D. and Ricardo Boric, M.Sc. we demonstrated that the large El Soldado manto-type copper deposit in Nogales, Quillota (has been exploited for 180 years and still employing more than 1000 people) was a reservoir of oil (Fig. 15)

Mina El Soldado, Nogales 1842



Da hoy empleo a 1080 personas

Bitumen (petróleo sólido) anterior a bornita y calcopirita en El Soldado



Economic Geology (1999) Wilson & Zentilli

before being invaded by hydrothermal solutions with copper.

- 5) During my work for the IIG I got to study the historic (early 1800s) sulphur mines belonging to the industrialist Matías Cousiño in the Copiapó (or Azufre - Sulphur) volcano (**Fig. 16**). From my field mapping, isotopic data, and mineralogy, I was convinced that under the sulphur there could be an epithermal system with gold. Colleagues insisted that: "It is too high" (5000 m) and that "The volcanism is too young". In 1990 I prepared a promotional brochure/report for the Cousiño family estate, who were close friends of my sister Mónica. Until then they only had mining rights for sulphur. My report suggested exploration steps. The Volcán property has passed through several hands, and today they tell me that it hides 9 million ounces of gold.

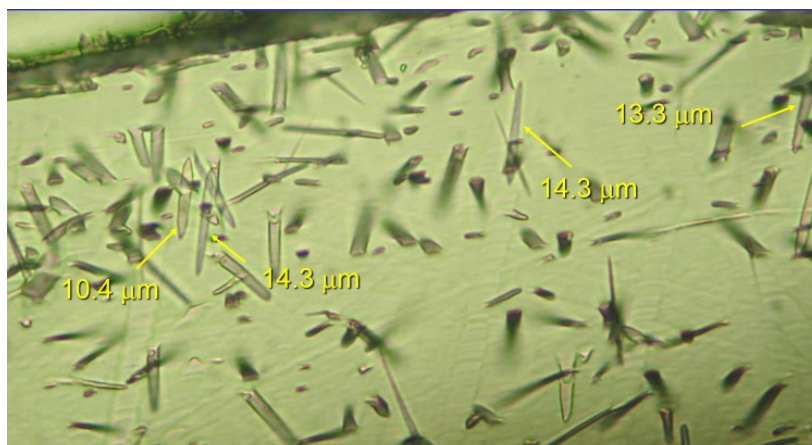
Volcán Azufre o Copiapó, Maricunga



Zentilli et al. 1991; Stark and Zentilli 1992

- 6) In Canada, in the 70s, I created the first (and still the only one in Canada) laboratory of nuclear fission tracks in apatite (**Fig. 17**), a method that allows us to date the time when the rocks cooled below 100°C, thus allowing to date and model (time-temperature) the rate of uplift of mountains and that has applications in metallogenesis and in oil basins. The laboratory is still running after 48 years, now in the hands of a skilled colleague.

Trazas de fisión en apatita



Maksaev & Zentilli (1999); Cembrano, Zentilli, Grist & añez (2003);
Gana - Zentilli (2000)

I never stopped feeling like a transplanted Chilean and I have helped, encouraged and given talks and classes about Chile whenever possible. In Canada they know that I am Chilean and a Geologist. Lately I have been teaching a course of “Geology in everyday life” as a volunteer teacher for the Nova Scotia Seniors College.



**Excellence in Geoscience Award – 2019
Geoscientists Nova Scotia (APGNS)**



**Gesner Medal - 2015 - Distinguished Scientist Award -
Atlantic Geoscience Society (AGS).**



Queen Elizabeth II's Platinum Jubilee Medal
by Lt.-Governor Arthur J. LeBlanc: “For significant contribution to
Canada, Nova Scotia, or their community”. November 24th , 2022

(Fig. 18) By presidential decree of former Chilean President Michelle Bachelet in 2009, since 2010 I am the Honorary Consul of Chile for the Atlantic Provinces of Canada, in Halifax, and that earned me a Canadian government medal, Queen Elizabeth II's Platinum Medal, 2022.

In closing, again, thank you very much, colleagues and friends of the College of Geologists and FEXMIN, you have made me feel part of the community, which encourages my soul and fills me with pride.

Marcos Zentilli van Kilsdonk
Halifax, Canada
Agosto 29, 2023

https://scholar.google.com/citations?hl=en&user=ATDW504AAAAJ&view_op=list_works