STRUCTURAL GEOLOGY & TECTONICS CAREER CONTRIBUTION AWARD

Presented to
Richard H. Sibson

Richard H. Sibson
University of Otago, New Zealand

Citation by Barbara E. John

It is my pleasure to introduce Professor Richard (Rick) H. Sibson the 2011 recipient of the Career Contribution Award. This award is given to an individual who throughout their career has made numerous distinguished contributions that have clearly advanced the science of structural geology or tectonics, and 'distinguished contributions' is a very apt description of Rick's career studying earthquakes in the field as a geologist. In fact, I know each of us has been influenced by his contributions toward understanding the structure and mechanics of crustal fault zones, but some may not know the man—for those a brief history.

Rick was born and raised in Auckland, New Zealand the son of R.B. Sibson (classics master at King's College, life-long birder, and inveterate island-hopper), and J.W. Fleming, sister of Sir Charles Fleming, Chief Paleontologist with the New Zealand Geological Survey. This auspicious birth led to his love of the outdoors, a career choice likely prejudiced by his uncle, and an ability to recite literature at any time and place. At the University of Auckland, he was strongly influenced by an inspirational class in structural geology taught by Professor Arnold Lillie. At the same time he took up caving and exploring old gold-silver mines east of Auckland, which likely led to his later diversification from pure structural geology into the structural controls on ore deposits, and processes of mineralization.

In the 1970s, Rick was a post-graduate at Imperial College London, where his PhD supervisor, Janet Watson, had the wisdom to let her students run by themselves and 'follow their noses'. And so he did, selecting his field area on the basis of a New Scientist article by Peter Francis entitled 'The Geology of Whiskey Galore'. Rick's investigation of the deep-seated 'guts' of the ancient fault zone exposed adjoining the peat bogs of the Outer Hebrides (Scotland) convinced him of the relationship between structural geology and earthquake rupturing. His thesis recognized that systematic changes with depth in fault rocks could be used to define a mechanical transition in the crust between brittle near-surface faulting and deeper, more ductile shear zones. This work defined the basic architecture of fault zones, and presented the terminology for fault rocks that remains widely used today. It emphasized the important point that 'earthquake geology' extends below the dirt levels beloved of paleoseismologists well into the 'underburden'.

In the early 1980's Rick was invited to the Office of Earthquake Studies at the USGS in Menlo Park. This 'intoxicating' environment led to him recognizing the correlation between the depth distribution of crustal earthquakes, and his earlier fault zone models, transforming our understanding of faulting processes and earthquakes. In 1982 he moved to U.C. Santa Barbara where Rick mentored me. There I was called into service to aid him in his newfound passion of 'launching' from remote mountaintops strapped into nothing more than a pair of dacron wings, hoping to fly—something he called hang gliding. I felt the need for him to remain alive to sign my dissertation so decided monitoring his activity was reasonable. At the time I worked on well-exposed low-angle normal faults whose existence Rick reluctantly admitted though he considered them mechanically unfeasible. Over the same period he was developing comprehensive models highlighting the interrelationships between fluid flow, faulting, and earthquakes in the crust. This led to his fault-valve model tying the earthquake cycle to the flow of overpressured fluids and mineralization. By applying simple mechanical principles, Rick demonstrated that transient permeability generated by earthquake rupture can lead to fault-hosted hydrothermal mineralization; a concept that is now widely utilized in gold exploration.

In 1990 he returned to New Zealand as Professor and Head of the Department at the University of Otago. Since his return 'home', Rick has continued studying natural examples of deformed rocks from denuded fault zones and hydrothermal mineral deposits. He quietly/calmly but repeatedly reminds our (structural geology) community that rock structures we consider as developing slowly and steadily in the upper half of the crust are likely accomplished by earthquake faulting. Integral to this mission has been raising public awareness of earthquake hazards surrounding the New Zealand plate boundary, and Pacific Rim in general. However, this did not stop him and his geologist wife Francesca Ghisetti from acquiring property near Christchurch City! He helped define the scientific rationale and objectives for the NSF/USGS San Andreas Fault Observatory at Depth (SAFOD), and continues to contribute to the drilling program on New Zealand's Alpine fault.

Rick, you have had a profound influence on both pure and applied geosciences over more than 35 years, and are truly a distinguished international scientist. It is therefore my great honor to present to you the 2011 Career Contribution Award from the Structure and Tectonics Division of the Geological Society of America.

Response by Richard H. Sibson

Thank you Barbara John for your very kind remarks. Once, during a break from field-camp Bobbie drove my truck while I was desperately trying to avoid getting sucked up into a thunderhead in Owen's Valley—an early near-death experience—so it is entirely right that she should be here giving this citation. More properly, one should note that graduate students like Bobbie always teach you a lot more than you teach them—*"I don't care what your mechanics tell you, Rick—look at the rocks—you just cannot deny the physical existence of low-angle normal faults!"*

The biologist Jacques Monod tells us that ***life as a whole evolves through chance and necessity***—a pretty fair description of my own career adapting to changing circumstances. Back in pre- plate tectonic days, my grounding in structural geology and tectonics at the University of Auckland came from Arnold Lillie who had mapped the high Southern Alps around Mt Cook with

the help of a field assistant called Ed Hillary. My transition to Imperial College in London in 1969 was due largely to Arnold's coercion in forcing me to sign a series of scholarship applications.

Some will recall 1968 as the magic year when many of the fundamental papers of plate tectonics were being published in the *Journal of Geophysical Research*—intoxicating reading for someone growing up in an island arc. One that particularly impressed was '*Seismology and the New Global Tectonics*' by Bryan Isacks, Jack Oliver, and Lynn Sykes—earthquakes, apparently, had something to do with displacement along plate boundaries. I thus arrived at Imperial College to study quantitative structural geology with a head full of the new-fangled notions of plate tectonics. With this in mind I sat through John Ramsay's cohesive and wonderfully flowing lectures on the earth as a ductilely deforming continuum, occasionally wondering whether anything fast and violent ever occurred in structural geology. But Neville Price's 'think of a number' approach combined with Ernie Rutter's materials science set me off along another track! Around that time earthquakes appeared as 'flyspots' on maps and were the property of seismologists—they were not generally considered part of structural geology. However, over in Civil Engineering, John Tchalenko and Nick Ambraseys were preparing wonderfully detailed maps of the 1968 M 7.2 Dasht-e-Bayaz rupture in central Iran where c. 4 m of left-lateral strike-slip had occurred in just a few seconds.

Then came the problem of selecting a PhD topic. Daunted by the vast literature on the Alps, I decided to have a crack at the peculiar 'flinty crush phenomenon' associated with the Outer Hebrides Thrust and somehow persuaded Janet Watson that 'those awful rocks' were worth studying. Structural geologists have a bad tendency of being distracted by beauty but 'rock uglification' also turns out to be important. Demonstrating that the pseudotachylytes so widespread in the Lewisian Gneisses of the Outer Hebrides were 'fossil earthquakes' and reconstructing the rheological structure of an ancient thrust zone was enormous fun but I soon realized I needed to know a lot more about modern earthquake processes.

In 1981 I had the great fortune to be a Visiting Scientist in the Office of Earthquake Studies at USGS in Menlo Park where I encountered the generous hospitality of the Californian earthquake science community—Tom Hanks, Dave Hill, Art McGarr, Bill Ellsworth, and many others including the great Bob Wallace who began as a mining geologist but was surely the pioneer of modern Earthquake Geology. Then came the move to UC Santa Barbara working alongside John Crowell and Art Sylvester. NSF was surprisingly supportive though I do recall one review that noted: "Sibson's idea of field work seems to consist mostly of touring". Quite right—if you see the same field relations in a variety of locations you may be looking at something important! A growing interest in fluid activity in the ductile roots of fault zones then led me to the Archean shield of Canada where I was introduced to the wonderland of mesothermal lode gold systems by Howard Poulsen and Francois Robert of GSC.

My return to New Zealand to the University of Otago in 1990 allowed me to continue work in these three overlapping fields—structural geology of fault zones, the mechanics of shallow crustal earthquakes, and the role of faults and fractures as fluid conduits for mineralization. Sadly, I had to let go of the hang-gliding. Many of our students first find employment in the Archean craton of Western Australia but I like to think that growing up on the active Pacific Rim contributed to their education.

To a student of active Earth processes, the South Island of New Zealand is a geological paradise. But as you all know, much of geologic process resembles warfare—long periods of boredom punctuated by short periods of unusual interest (and terror!)—so you have to be careful what you wish for. The ongoing earthquake sequence around our newly adopted city of Christchurch in fact turns out to be a classic example of conjugate 'Andersonian' wrench faulting. But the fascination of 'living over the shop' certainly fades after a year of rich and violent aftershock activity!

A structural geologist is soon lost without a compass. The America I knew, lived in for 10 years, enjoyed hugely and benefited from immensely, was the land of boundless possibility, of "let's make it happen", of science as "the never-ending frontier", of "the only thing we have to fear is fear itself". It was not the America that condones torture, abandons habeas corpus, and conducts drone assassinations. This seeming 'loss of moral compass' is of enormous concern to friends of America around the world.

That said, I am grateful beyond words to the Geological Society of America for this award, to my parents who let me fly free, to all my colleagues and students, and most importantly to my wife Francesca Ghisetti—best of companions.

Thank you all very much indeed.