Ralph J Archuleta, Emeritus

Professor Chris Scholz at Columbia University once wrote: "Seismology has always been regarded by the public according to the dictionary definition—the science of earthquakes—but the fact is that most seismologists do not study earthquakes. … the great research program of seismology: the determination of the internal structure and constitution of the Earth from the propagation of seismic waves, in which earthquakes became merely the 'seismic source,' the clapper that rang the bell. The interest was in the bell, not the clapper." Ralph's interest has always been on the clapper—the seismic source. That interest started with his PhD research in which he modeled earthquakes as stick-slip events on a precut fault in a foam rubber block, recorded the 'ground' motion with a high-speed camera (5000 f/s) and analyzed the results which were consistent with theory. He and his advisor Professor James Brune both knew that while the analog simulations were interesting, simulating earthquakes by numerical modeling was more likely to lead to an extended professional career in seismology.

That career had its origins much earlier while growing up in Reliance, Wyoming—a small coal mining camp near Rock Springs (4th largest city in Wyoming, pop. ~10,000). After watching his dad load and unload 100 lb bags of cement, Ralph (at 13) decided that intellectual labor would have to replace physical labor. Of course, it was a pipe dream to become a nuclear physicist. That dream motivated him to pursue physics one year at Western Wyoming Community College (now Western Wyoming College) and then at the University of Wyoming. He entered the University of California, San Diego in physics to study the magnetosphere. He earned a MS and left to take a computational programming job at a software company in San Diego. There he worked on modeling explosions and differentiating their signature from earthquakes. It was serendipity that a Caltech professor, a consultant to the company, introduced Ralph to Brune at the Institute for Geophysics and Planetary Physics at UC San Diego. Brune laid out an unsolved problem that he would like solved. With incredible bravado Ralph explained how he could solve that problem using the numerical codes he was using. Although skeptical, Brune said he would accept him as a PhD student for the fall of 1972; this conversation was in June—well past the deadline for applications.

After his PhD and a one-year postdoc at IGPP, Ralph was awarded a National Research Council Fellowship to work at the US Geological Survey in Menlo Park, CA. There he produced his magnum opus—faulting model for the 1979 Imperial Valley earthquake. In this paper he demonstrated that the rupture velocity had to exceed the shear wave speed of the medium on a ~15 km long segment of the Imperial fault. While theory had shown that this was possible, there had been no observational evidence of such a phenomenon. The overwhelming majority of seismologists were skeptical (as they should be of such an unusual result) or politely ignored the result. With the 1999 Izmit earthquake (M7.6), 2001 Kunlun earthquake (M7.8), 2002 Denali Fault earthquake (M7.9, among others as well as sophisticated laboratory experiments, it is now widely recognized that the earthquake rupture front can propagate at supershear speed.

After seven years at the USGS, Ralph applied for a position in the Department of Geological Sciences (now Earth Science) at UCSB. Fortunately, he was selected and started as an associate professor in 1984. A major consequence of understanding the mechanics/dynamics of an earthquake is that one can predict the strong shaking in the vicinity of the fault. That shaking can be strongly affected by local geological site conditions. One of the first major projects he started was a program to place accelerometers below ground surface, some would reach ~1800 ft depth, to measure the waves as they propagate from the hard rock into the sediments. This was primarily funded by the US Nuclear Regulatory Commission who had a primary interest in site effects. This borehole project was greatly expanded by Dr. Jamie Steidl (one of his PhD students) and now includes seven geotechnical arrays from California to Alaska.

While the local site effect has a major role, so too does the large-scale complexity of the subsurface geology structure. Using one of the first parallel computing systems K. Olsen (postdoc, now professor at San Diego State University), J. Matarese (computer scientist), and Ralph produced the first numerical simulation of a M 7.8 earthquake on the San Andreas in a three-dimensional medium that included the deep basin structure in Southern California. With computational power sufficient for modeling Ralph and his students and fellow researchers embarked on a wide-ranging research program to explore how ruptures jump from one fault to another; how the Earth's surface affects the dynamics of an earthquake rupture, supershear rupture effects on ground motion; effects of stochastic rupture parameters, etc. In all of this the motivation has come from trying to predict ground motion that is comparable to data. We cannot predict exactly what ground motion the next earthquake will produce, but simulations can predict a suite of ground motions from which one can estimate the expected ground motion and its uncertainty. This information is used by earthquake engineers to design seismically safe structures.

Geological Catastrophes ES 20 is a course that the late professor R.V. Fisher and Ralph started in 1991 following the 1989 Loma Prieta earthquake. It is a GE course that satisfies quantitative relations. Initially the course was taught once per year, but the waiting list was so long that the Department decided that it should be taught every quarter plus once during the summer. It is a popular course with enrollments generally limited by the classroom size. Around 2005, UCSB students rated (Daily Nexus balloting of students) ES20 as their second favorite class on campus. (#1 was human sexuality—no contest.) This course provides students with an understanding about how the natural forces that are continually acting on the planet can lead to phenomena that have serious consequences for society.

With the benefit of 14 PhD students, 8 postdoctoral and professional researchers, Ralph has more than 123 publications. Among his accolades are: 2008 Harry Fielding Reid Medal of the Seismological Society of America (its highest honor); 2011 Fellow, American Geophysical Union; 2003 Distinguished Alumnus, University of Wyoming; 2004 Distinguished Alumnus (1st Recipient), Western Wyoming College; 2002 Commemorative Medal '100 Years of Seismology in Slovakia'. He served as Chair of the Scientific Earthquake Studies Advisory Committee (SESAC) for the U.S. Geological Survey from 2012-2018. This committee, mandated by Congress, provides advice to the USGS earthquake hazards program. For six years he chaired the USGS Advanced National Seismic

System. He led UCSB’s effort to be part of the Southern California Earthquake Center and served as its Board member for almost 25 years. He has been President and Vice-President of the Seismological Society of America. He led the effort to establish a web-based relational database of strong motion data collected worldwide; this is now part of the Center for Engineering Strong Motion Data. He has been a consultant on critical facilities for many national and state agencies including the US Nuclear Regulatory Commission, Federal Energy Regulatory Commission, US Bureau of Reclamation and the California Division of Dam Safety.