On practical steps to extract seismic signals from nuclear explosive testing—underwater, in the atmosphere, and underground—from U.S. archives of analog seismograms

Paul G. Richards (Columbia University, New York)
PI: Paul G. Richards: richards@LDEO.columbia.edu; 845-365-8389
Consortium for Verification Technology (CVT)

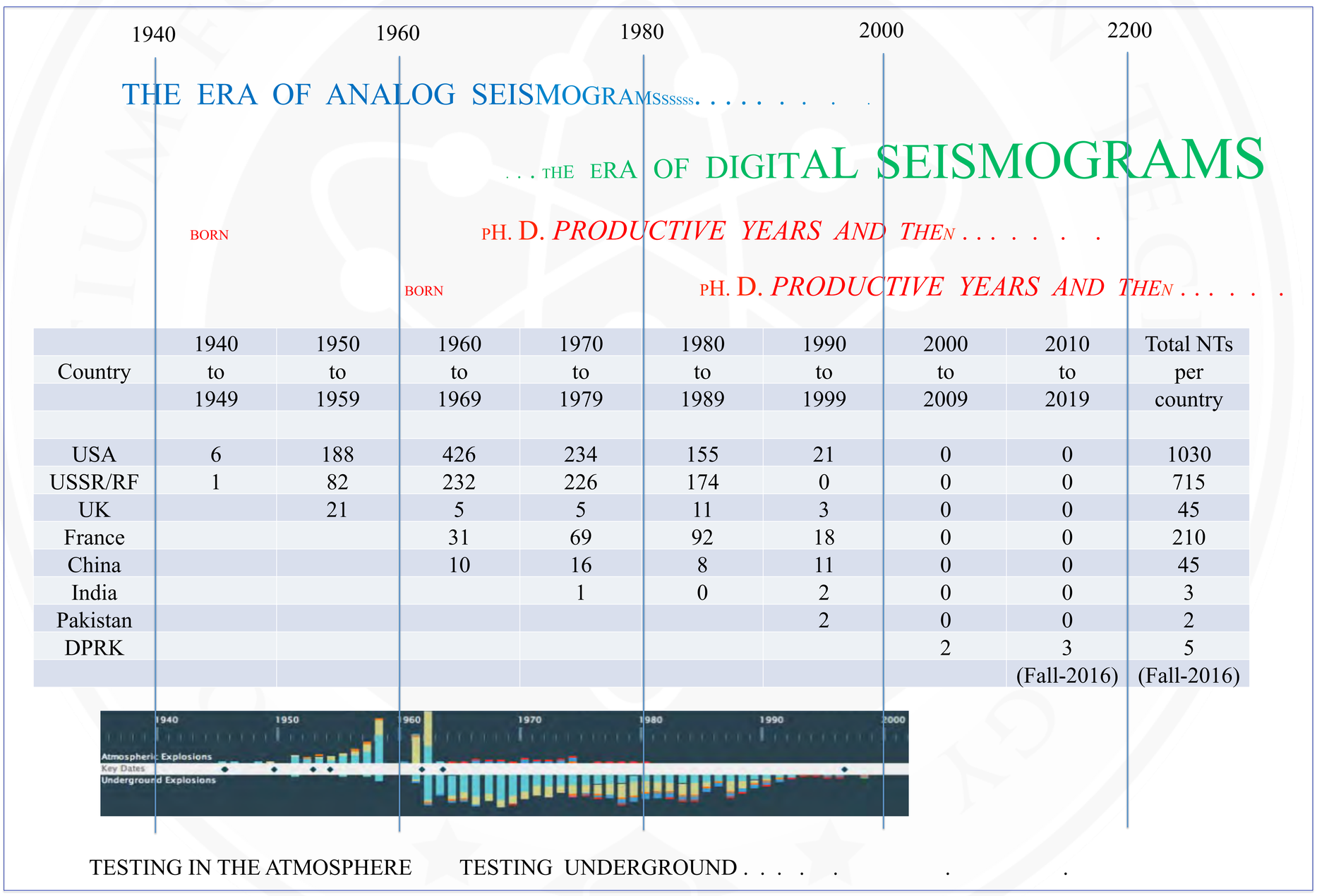
Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY / EARTH INSTITUTE

Seismology is an observational science, continually surprising us with features in seismograms that are not fully explained by current theories of wave propagation applied to current models of earthquake and explosion sources, and models of Earth structure.

Since the early 1980s, seismic ground motion has been documented via digital recordings that for many stations are commonly made easily available to the research community. There are questions about access to digital data from stations not easily available in this way, but this presentation asks "what to do with the information acquired earlier, during decades of analog recording, when most nuclear test explosions occurred?" There is more than 25 years of experience in Europe and in Asia addressing the question of how to rescue earthquake seismograms recorded in the analog era, and a somewhat different history of data rescue efforts in the United States, where on the order of ten institutions, holding millions of analog seismograms, are beginning to ask how long to maintain such archives. Horror stories abound, of major archives discarded without enough thought, and of losses to flood and decay.

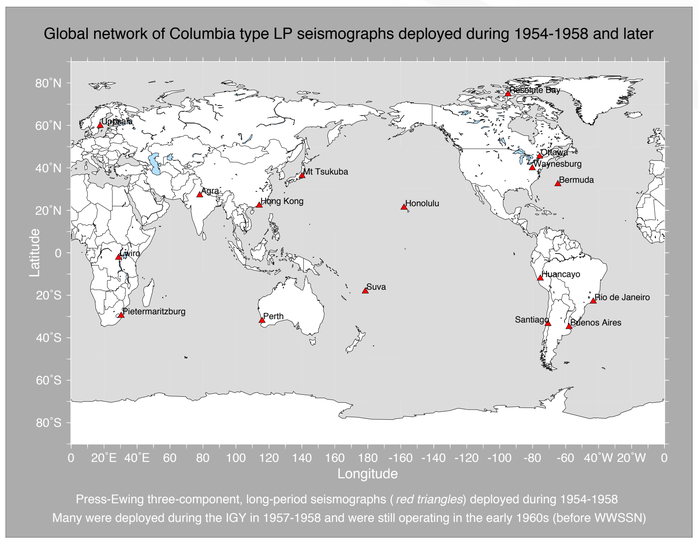
The main graphic here, shows timelines: for nuclear testing, for different types of data acquisition; and for careers of old and young.

Opportunities for interaction between those familiar with analog seismograms, and modern analysts, will not last indefinitely. Data rescue entails: event selection; searches for records; scanning; digitizing; and setting up systems for distribution with metadata. We have done this work for nuclear test explosions in Eurasia. The effort to do this for nuclear test explosions in the continental U.S. (including Alaska) and in the Pacific is a management problem, costing far less than acquisition of new data from chemical explosions.

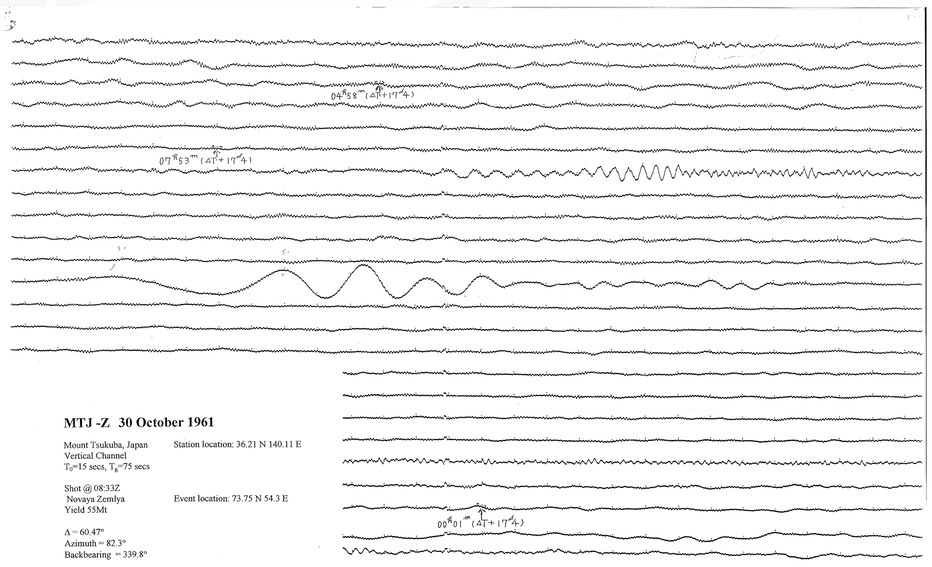


Country	1940 to 1949	1950 to 1959	1960 to 1969	1970 to 1979	1980 to 1989	1990 to 1999	2000 to 2009	2010 to 2019	Total NTs per country
USA	6	188	426	234	155	21	0	0	1030
USSR/RF	1	82	232	226	174	0	0	0	715
UK		21	5	5	11	3	0	0	45
France			31	69	92	18	0	0	210
China			10	16	8	11	0	0	45
India				1	0	2	0	0	3
Pakistan						2	0	0	2
DPRK							2	3	5
								(Fall-2016)	(Fall-2016)

The map shows an early global network, installed prior to the Worldwide Standardized Seismographic Network of 1962–1980s. Tens of thousands of seismograms exist today, of signals recorded in analog formats from nuclear test explosions above and below ground.



The largest wave shown here in this vertical-component analog seismogram from Mt. Tsukuba, shows an acoustic-gravity wave associated with a change in buoyancy acting on the inertial mass, from the Big Ivan test of 1961 at Novaya Zemlya.



This work was funded in-part by the Consortium for Verification Technology under Department of Energy National Nuclear Security Administration award number DE-NA0002534

National Nuclear Security Administration