

# Test-Ban Verification at the Intersection of Basic and Applied Science and Innovation

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# CTBTO

- An organization created to detect clandestine nuclear tests
- Generates massive amounts of data and latest technologies
  - Seismic, hydro acoustic, infrasound, and radionuclide
- Need to develop and use onsite inspection technologies
- This makes CTBTO both a user and a supplier of innovation and science

- Traditional thinking on innovation is linear
- Process starts with basic curiosity driven research
- Followed by applied science and engineering studies
- In some cases to creation of patents and spinoff companies
- In some cases the application to processes and manufacturing
  - with good luck to wide spread adoption

- But innovation is typically non linear
- Sometimes divided into supply side and demand side
  - Basic research is the supply side
  - Public policy or private need represent the demand side
- Smart procurement to meet public need can be instrumental

- We know the impact of the physics revolution of the 1920s/30s.
- Some estimate that this is responsible for as much as 50% of the GDP of today's US
- *“Where Good Ideas Come From – the Natural History of Innovation”* a recent book
  - This book uses evolution as a model for the process of innovation
  - First chapter – Reef, City, Web capture the idea of vibrant life and interactions

- Last chapter outlines innovations of the past two centuries
- Focus is the move from individual innovation to networked innovation
- Hubs of interacting complexity resemble the web itself
- Analogy to evolution is that networking and communication are drivers of both

There are many examples in the earth sciences showing the results of interaction between supply and demand...

- Which came first?
- The technology of new instruments or technologies?
  - A public or a military need?
  - A scientific breakthrough ?

- The planetary revolution that followed the Apollo missions to the moon
- The Apollo missions were designed for a well determined public purpose
- Demonstrate the US superiority in technology
- Science was a byproduct but fortunately was supported
- But the surface experiments and the returned lunar samples documented the nature and evolution of a sister planetary body



- Provided information about a period in solar system history not previously available
- Documented the early volcanism and an intense bombardment period
- Determined the chemical composition, magnetic field and internal structure
  - First extraterrestrial seismic network established
- Using bombardment history timetable provided a method of dating other planetary surfaces

- Led to the extensive rewriting of the history of the solar system
- Led to deeply increased interest in the study of meteorites
- Provided a great deal of information about the origin of the solar system
- The public objective of the Apollo mission clearly led to very rapid development of solar system science and a revolution in planetary science

# Earth System Science and the Plate Tectonics Revolution

- Much networking and communication was key to the plate tectonics revolution
- Consider the magnetometer
- First developed by the oil industry before WW11 for geologic mapping
- Adopted by the US Navy for submarine detection
- Manufactured by Texas Instruments as its first government contract

- Modified after the war for use again for geologic mapping
- Adopted for mapping of the sea floor
- Put into widespread mapping of the Atlantic to find suitable places to hide submarines
- Symmetrical magnetic stripes found on both sides of the mid Atlantic ridge
- These stripes coincided in distance from the ridge to the time sequence of the Earth's magnetic field reversals
- A key plank in the evolving story of spreading centers

# The Distribution and Mechanism of Earthquakes

- Intense earthquake studies were focused on earthquake prediction
- This led to the creation of global networks of ever better detector technology
- Then came the need to monitor for clandestine nuclear explosions
- Scientific understanding of earthquake mechanisms were elaborated
- CTBTO produces remarkable information on the distribution and mechanism of earthquakes

- This understanding of earthquakes was a central plank in the plate tectonics revolution
- CTBTO continues to provide a basis for outstanding science
- This outstanding science is crucial to their mission of nuclear monitoring
- Innovation and scientific breakthroughs result from networks and communications
- New technologies often derive from basic science
- Basic science often comes from new technologies and from meeting public or private need

- CTBTO has the need for onsite inspection when an explosion has been detected
- There is a long record of geophysical and geochemical exploration techniques in the search for mineral deposits
- CTBTO is the beneficiary of these
- CTBTO will be able to adapt and improve many of these techniques including the use of modern drone technology
- This will in turn improve approaches to near surface geologic mapping technology

Innovation is much like  
evolution  
and depends on the fact that  
supply and demand  
interact with each other