



# Historic Explosion Data Preservation and Analysis Efforts Sponsored by U.S. Department of State / AVC

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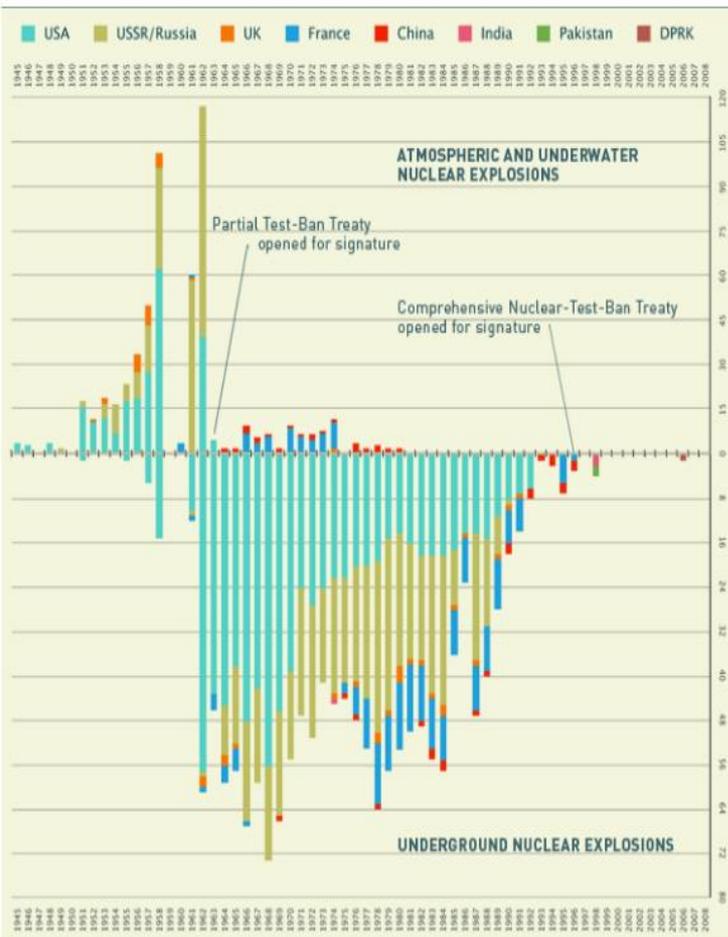
The views and opinions reflect those of the presenter, as DOS/AVC Senior S&T Advisor.



## What Will This Panel Discuss (and Why?)

- DPRK-declared tests (2006-2017) offered an opportunity to test methods and gain experience regarding the estimation of **absolute and relative event location, overburden, and magnitude**.
  - But that experience is confined to a small, specific test site.
- Broader experience can be gained by applying modern analytical methods to the vast amount of data recorded on more than 2,000 historic nuclear test explosions.
  - However, such data recorded during the analog era must be preserved and properly converted to usable digital form first.
- The goal of this session is to identify the priorities for continuing and expanding these data preservation efforts.
  - Historic data are needed from as many regions as possible.
  - New active-source calibration experiments are also needed in many regions.

# Why Legacy Historic Nuclear Test Data Should Be Rescued



**Nuclear Tests per decade, for different countries**

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	Σ NTs per country
USA	6	188	426	234	155	21	0	0	1030
USSR	1	82	232	227	172	1	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	4	6

(From Richards SnT2021/i01-722)

to June 18, 2021

Numbers in red: these explosions took place in the era of analog recording  
 almost all nuclear testing in the atmosphere took place in the analog era

Numbers in green: these explosions took place in the era of digital recording



- AVC's five recent *Broad Agency Announcements (BAAs)* issued in 2019-2021 routinely call for proposals on **historic explosion data rescue**, to address **digitization of rare historic explosion data sets**.
- AVC also invites proposals on **Region-specific Geophysical Calibration**, as prioritized in the *"National Defense R&D Strategic Plan 2020-2024"* (Dec 2019, Page 5). Both **controlled active-source experiments** (e.g., mini-JVE-like chemical explosions) and **passive seismic/infrasound (and other geophysical) deployments** are welcome and encouraged.
- Data collection/sharing is only the first step, many associated studies (and innovative analytical tools) are needed to enable a judicious analysis of events of concern.

# Q4a. What Data/Studies Are Important, and Where Are We?



*International team from Michigan State University, the Institute of Geophysical Research of Kazakhstan, and the Federal Research Division of the U.S. Library of Congress join forces to index and engineer the preservation and recovery of Deep Seismic Sounding data in Kazakhstan*



*Kazakhstan DSS Profiles with data archived at the IGR*



*Vintage VSS-6/13 magnetic tape data recovery and digitization system*

- Project seeks to re-engineer the magnetic tape data digitization and recovery systems at the IGR in Kazakhstan. Previous efforts found the vintage systems available in Kazakhstan to be deteriorated.
- Most analog tapes in Kurchatov are in moderately good condition. Some show deterioration, though are likely restorable. Digital tapes in Borovoye are in good condition.
- The available data tapes have been cataloged and the available metadata recovered.
- Future recovery of the DSS data could provide a wealth of data for regional crustal models and nuclear explosion discrimination.



*LOC evaluating state-of-health of analog data tapes in Kurchatov*

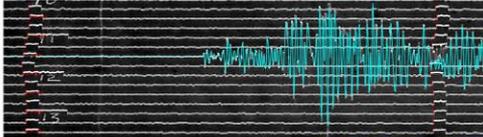
V Fund BAA18 18P1798

- AVC has contributed partial funding for several historic explosion data rescue efforts, through recent BAAs.
- Some projects carry out actual digitization, development of standardized scanning /digitization procedures (and software), and facilitation of regional collaborative efforts.
- Some cooperative efforts along this line are described in SnT2021/ O2.5-298, P2.5-297, P2.5-397, P2.5-443, P2.5-499, P2.5-594, P2.5-89, etc.



**HARVARD UNIVERSITY**

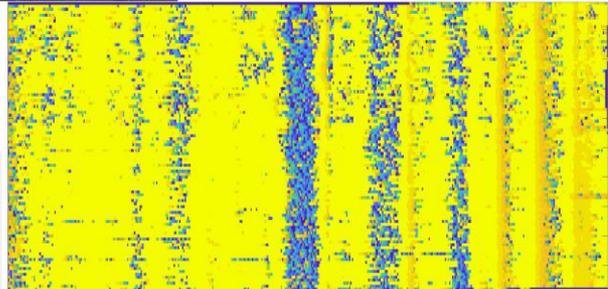
## Investigating the Feasibility of Extracting Digital Data from Analog Microform Seismogram Recordings



Screenshot of timed and digitized traces (black and cyan lines) showing the beginning of the ground motion from the Trinity test on July 16, 1945 recorded at Tucson, AZ. Red vertical lines indicate the beginning of each minute.

**BAA20-02, 20P1475**

Comparison of the digitized traces obtained from the original image and from microfilm. The colour plot (right) shows the level of horizontal stretching (orange and blue colours indicate horizontal contraction of the microfilm compared to the original). In the plot below, the degree of similarity of the recovered waveforms are given as correlation coefficient as a function of time. They are compatible for most part, but there also are notable differences.



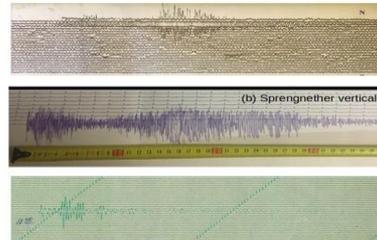
## Collection of Nuclear Explosion Legacy Data – CTBTO Support

**BAA20-03, 20P2144**



- ▶ Leidos team works with 4 national institutions in Europe (Austria, Bulgaria, Moldova, Romania) to rescue analog data for nuclear explosions: unique opportunity to rescue data with an Eurasian focus
- ▶ 75 stations in the 4 national networks, covering all period of interest: 1945-2017
- ▶ Over 400 nuclear explosions in a distance below 45 degrees and with mb>=4.5
- ▶ Over 50 explosions detonated in historical western USSR at regional distances

- Western ex-USSR, 1969/09/26, 10 deg., station KIS
- Novaya Zemlya, 1973/10/27, 30 deg., station VIE
- Mururoa, 1983/05/25, 153 deg.,

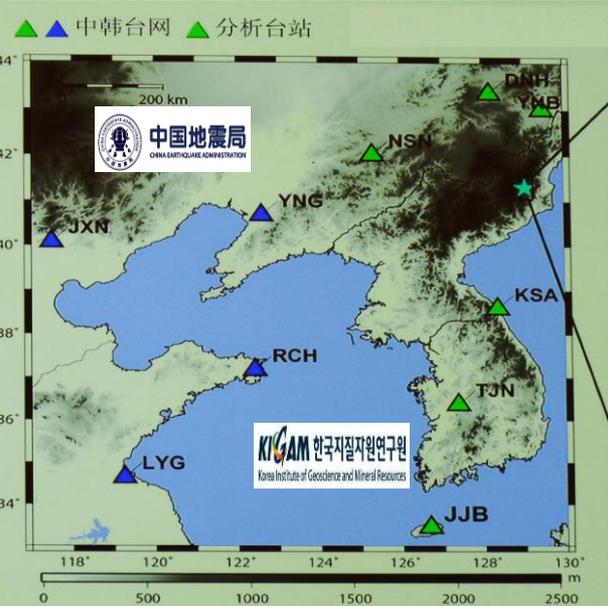
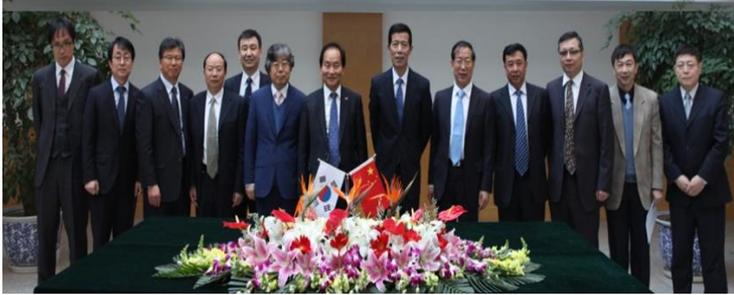


# Q5. What Additional (Data Sharing) Arrangements Can Be Made?



A good model for monitoring seismicity in a region-specific sense is to augment IMS data with effective sharing of local and regional data from national (and possibly non-IMS) stations, as China and ROK have successfully demonstrated -- essentially a “neighborhood watch” effort. Shown below is the **China-ROK Joint Seismic Network** (from SnT2017/T2.1-O8).

中韩地震研究合作谅解备忘录签字仪式  
 SIGNING CEREMONY OF THE MOU ON EARTHQUAKE STUDIES BETWEEN CHINA AND KOREA



The ROK NDC (at KIGAM) performs in-depth, broad-spectrum analyses of DPRK-declared nuclear tests with a ring of China-ROK joint (non-IMS) seismic stations surrounding DPRK (right, from SnT2019/T2.1-P28; AGU2017/S41G-05, etc).

China-ROK seismic MOU was renewed in 2015.

