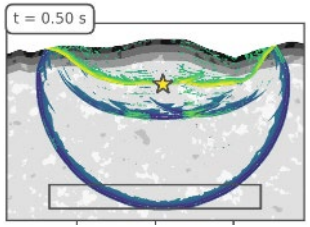
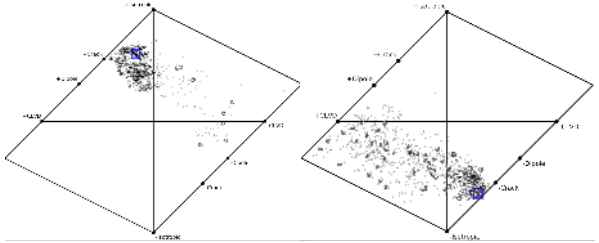
Panel Discussion: "Lessons from historic nuclear test explosions"

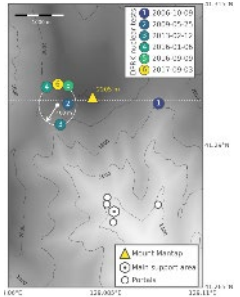
Lars Ceranna, lars.ceranna@bgr.de

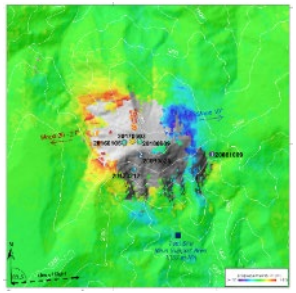
<u>Q1:</u> Data used by CTBTO from DPRK announced tests and historical nuclear explosions and for what purpose? What enhancements have been made, what are the shortcomings and what is missing?

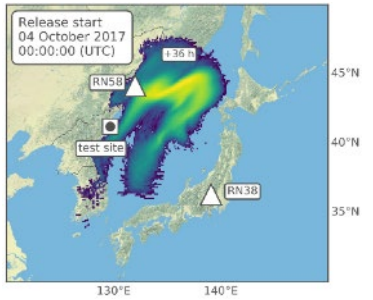
- "A multi-technology analysis of the 2017 North Korean nuclear test", Gaebler et al., Solid Earth, 2019 https://doi.org/10.5194/se-10-59-2019.











- "Verification of the North Korean Nuclear Explosions 2006, 2009, 2013, and 2016", Hartmann et al., 2017, in "Monitoring Compliances with the CTBT", Geolog. Jahrbuch, Series B, 105.
- Since 1976 the digital seismological GRF-Array is in continuous operations providing waveform data for "seismological finger prints" from all historic nuclear test sites.

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Q2: Why have no radionuclides been discovered following most DPRK announced nuclear tests?

- From the 2nd test on, DPRK managed to establish a sufficient initial containment even for noble gases.
- At least, only two tests (May-2009 and Sep-2016) had no associated noble gas detection at dedicated IMS station sites.
- Nevertheless, we have no detection of **early releases** from 2009 on: After the DPRK tests in Jan-2016 and Sep-2017 there were delayed detections of Xe-133, which were meteorologically consistent with the test site as source location, but not specific in terms of additional isotopes in a matching ratio.
- The fully consistent smoking gun was detected twice: 2006, supported by national measurements of additional isotopes few days after the explosion, and 2013 with delayed releases more than 50 days after the explosion measured by the IMS stations in Takasaki and Ussurysk.
- What about historic underground nuclear explosions?
- Do we overstretch our expectations as we are dealing with a sparse network of noble gas stations in remote places and a sophisticated ATM?

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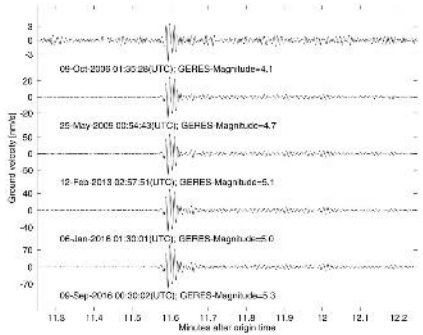
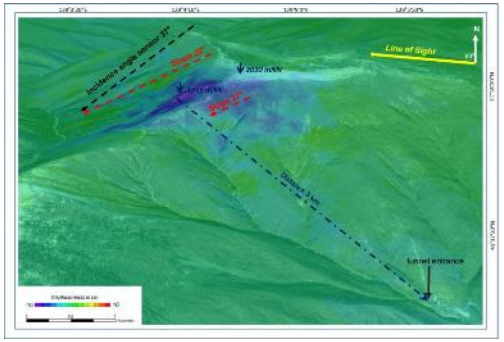
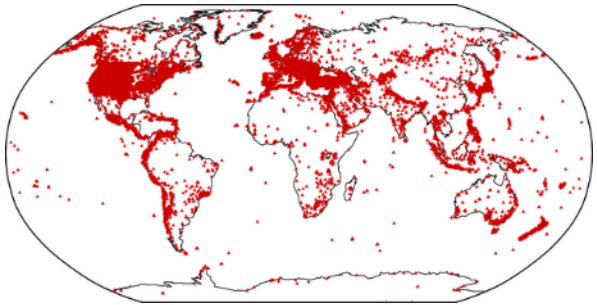
Q5: What can we learn from seismic data retrieval and preservation activities for hydro-acoustic, infrasound and radionuclide data? What other kind of monitoring data could be supplement the historic data based on sensor technologies of the IMS?

- Since 1976 the digital seismological GRF-Array is in continuous operations providing waveform data for "seismological finger prints" from all historic nuclear test sites
- National Technical Means: a) DInSAR images (EU's Sentinel mission); b) Freely available seismic data via FDSN web-services (>10,000 three component stations world-wide)







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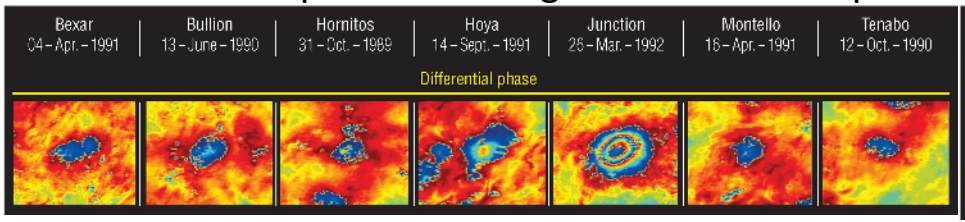
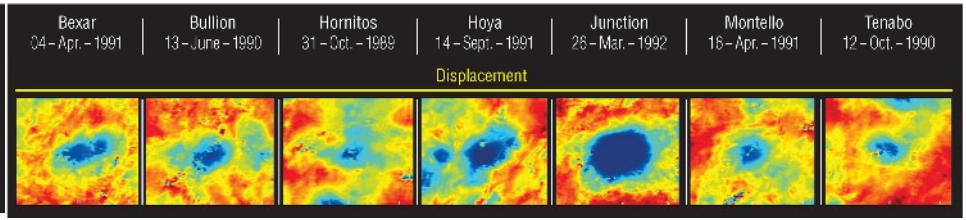
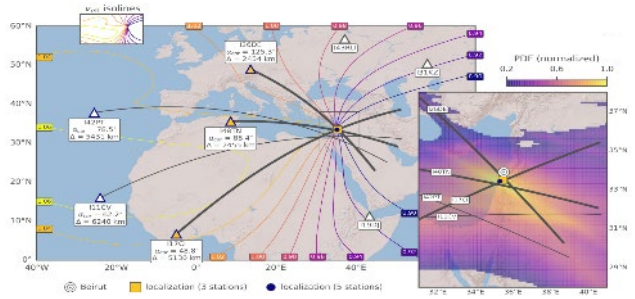
Q8: What has already been learned from historic tests?

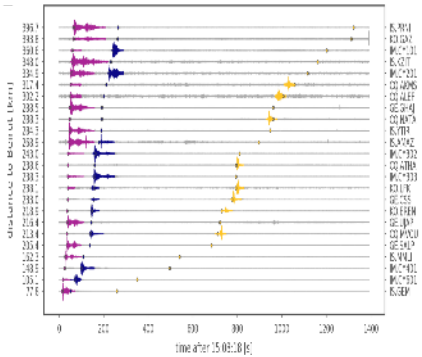
- Impact of atmospheric nuclear explosions; radionuclide fingerprint of such explosions.
- Surface imprint of underground nuclear explosions

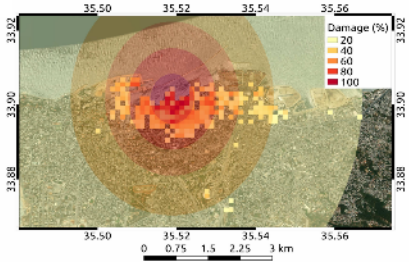


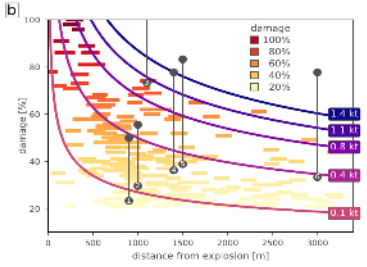


- Estimating yield of an explosion, e.g. 04-Aug-2020 Beirut accidental explosion (~1 kt yield)









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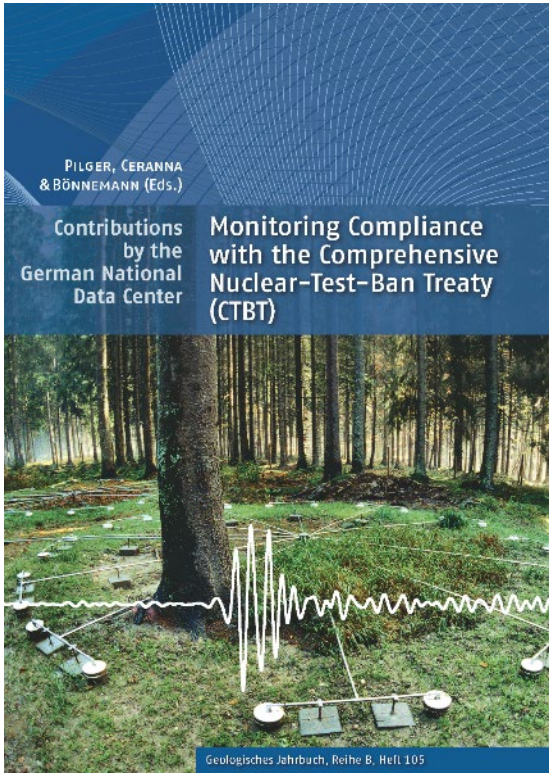
Monitoring Compliance with the CTBT – Contributions by the German NDC

Eds: Christoph Pilger, Lars Ceranna, Christian Bönnemann



- Presentation of actual research topics and advisory activity of the German NDC (BGR)
- Support of the political, public and scientific community with expertise related to the CTBT
- Collaboration of the German NDC with national and international partner institutions
- Release date: available since November 2017
- Pages: 328, Figures: 217, Price: 58 €
- *http://www.schweizerbart.de/publications/detail/isbn/9783510968589*

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since 2019: Head of the German NDC and the Federal Seismological Survey (BGR)

2009 – 2019: Unit Head for Monitoring and Verification (BGR, German NDC / Central Seism. Obs.)

since 2004: Scientific and technical adviser to the Foreign Office with respect to CTBT verification

2002 – 2008: Senior Researcher (BGR, German NDC; Focus: Infrasound and Verification Technologies)

2001 – 2002: PostDoc (Ruhr-University Bochum, Germany)

1998 – 2001: PhD in Seismology (Ruhr-University Bochum, Germany; Adviser Prof. H.-P. Harjes)

1992 – 1997: Diploma in Geophysics (Ruhr-University Bochum, Germany)

since 2002: Co-authored and authored >50 peer reviewed publications in the fields of infrasound, seismology, and verification technologies

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