



The Institute of Geophysical Research of the Republic of Kazakhstan possesses a large archive of analog records of nuclear explosions. The whole IGR archive can be conditionally divided into three parts: the records of former SSC MD USSR the archive of Borovoye Observatory (1966 - 1990) and Kurchatov Observatory (1973 - 1996), and the records of the CSE IPE AS USSR the archive at KNDC (Almaty) (1951 - 1996). The KNDC archive contains records of nuclear explosions conducted in different mediums at different Test Sites of the world and recorded by stations installed on the USSR territory. The archive also contains the records of large chemical explosions, earthquakes and other events. In addition to seismic records, the archive contains the records of microbarograph, strainmeter, tiltmeter. The total amount of analog seismograms at KNDC archive exceeds 300 000. The report shows the description and history of the IGR archive compilation, presents some examples of different nature events. One of the priority tasks of the IGR is saving of available historical seismograms. During past twenty years, under support of different foreign Organizations, the Institute has been conducting works on records scanning and digitizing. To date, about 10000 seismograms were digitized.

History of seismic monitoring for nuclear explosions in Soviet times

Since the beginning of nuclear explosions conduction and under the "Cold War" between the USA and USSR, the issue on possible monitoring of nuclear explosions at large distances became critical. 1951 - 1953 - typical seismic stations installed by the Geophysical Institute of the AS USSR (GEOFIAN) for seismic, geophysical, tectonic and other investigations recorded several explosions not only from the Semipalatinsk Test Site, but from foreign Test Sites too. It was decided to install special seismic stations and develop seismometers with high amplification. 1954 - establishment of the Special Monitoring Service of the Ministry of Defense, USSR, that in 1958 was transformed to the Special Control Service (SCS). Thus, from 1954 the first special seismic stations (civil and military) started to be installed through the whole USSR territory to record nuclear explosions signals.

Nuclear explosions monitoring stations installed on the territory of Kazakhstan in Soviet times
 1957 - The Special Control Service established on the territory of Kazakhstan the first special station for nuclear explosions monitoring - Semipalatinsk Laboratory.



By the end of 1969 the first experimental seismic array "Cross" was installed on the territory of Semipalatinsk Test Site. It allowed recording small underground nuclear explosions from Nevada Test Site and monitoring the explosions from 9 foreign Test Sites.

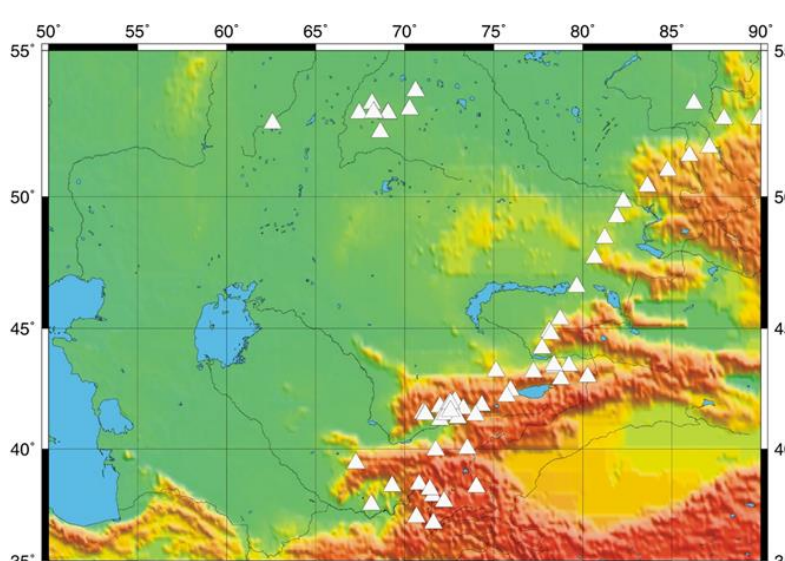
1961 - The Institute of Physics of the Earth (IPE) AS USSR (successor of GEOFIAN) installed a permanent seismic station in Borovoye to record nuclear explosions.



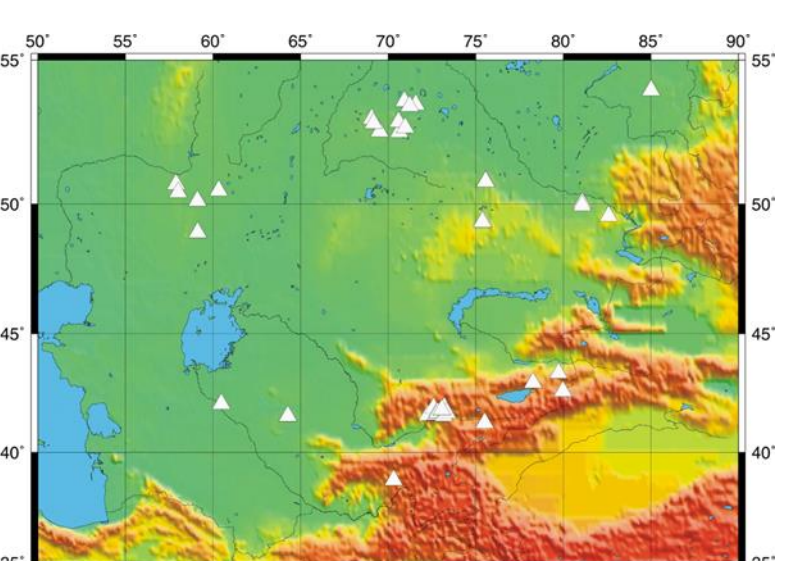
Here, from 1966 the nuclear explosions were recorded using first digital instruments; digital records of nuclear explosions and earthquakes were collected.

1969 - The Special Control Service installed its station in Borovoye too. Owing to the joint work of IPE and SSC, since 1970 the number of detected underground nuclear explosions including small yield explosions conducted at Nevada Test Site increased significantly. In addition to the USA and USSR Test Sites, Borovoye station also recorded signals of nuclear explosions conducted at the Test Sites of France, China, and India.

1961 - installation of special seismic stations by the Complex Seismological Expedition (CSE) of the IPE AS USSR.



The stations of CSE IPE AS USSR opened in 1960-1969

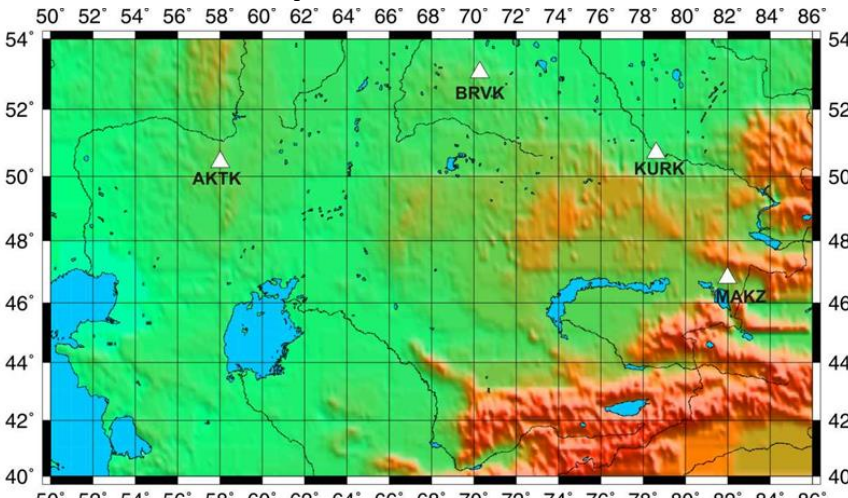


The stations of CSE IPE AS USSR opened in 1970 - 1988

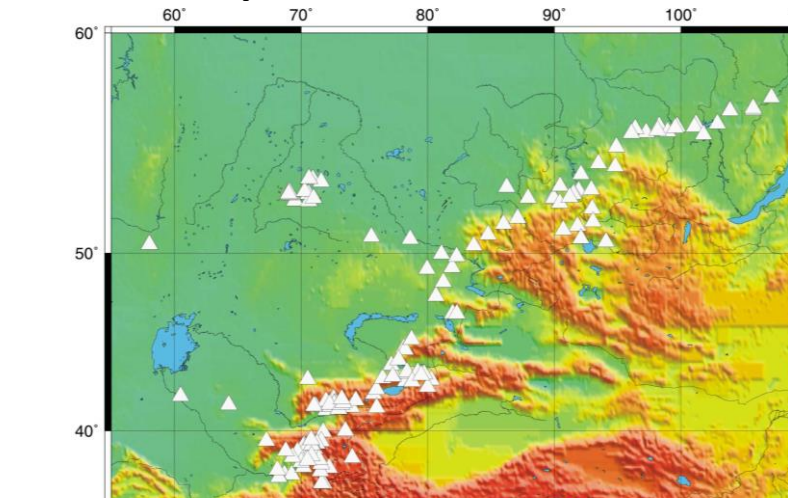
1970 - the Special Control Service installed Makanchi station in 60 km away from Kazakhstan border with China.



1985 - the Special Control Service installed another station - Aktyubinsk in the west part of Kazakhstan



The map of SCS stations location on the territory of Kazakhstan



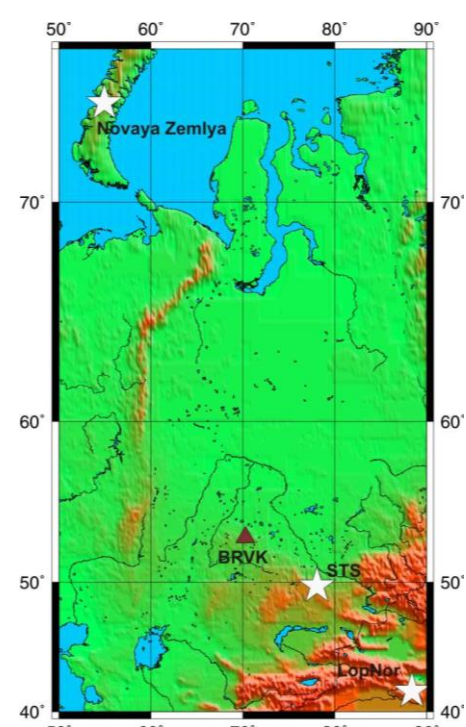
The map of CSE IPE analog Stations location on the territory of Central Asia

Thus, starting from 1960 the monitoring for nuclear explosions conducted on the USSR territory and abroad was conducted by the seismic stations especially installed for this purpose. The joint work of the Service of Special Control and the Institute of Physics of Earth allowed selecting suitable "calm" sites for the stations installation, develop new instruments for distant events recording resulted in obtaining the seismic records of nuclear explosions from all Test Sites of the world.

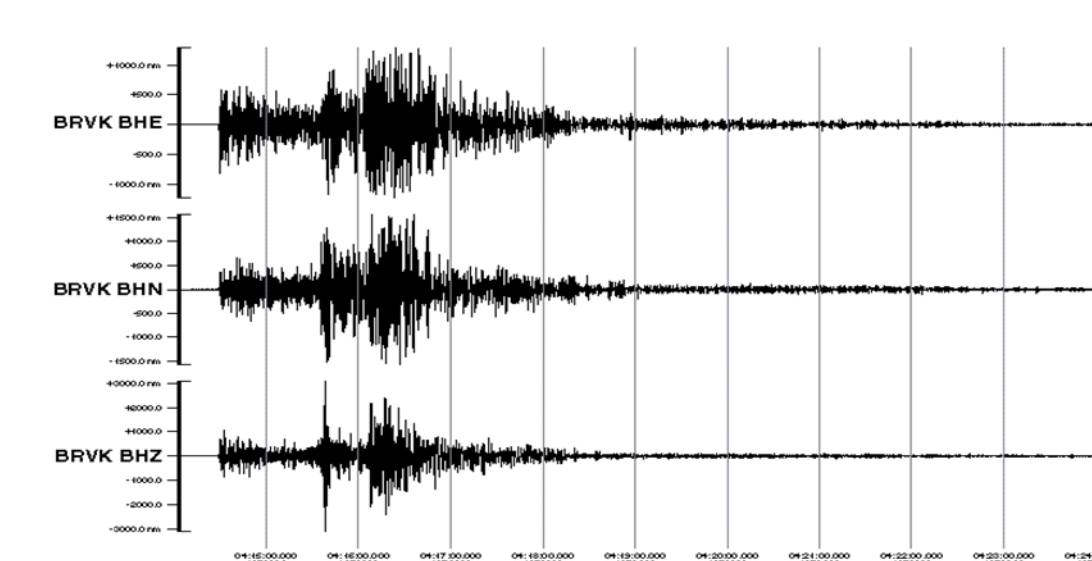
The structure of the Institute of Geophysical Research archives

After the Soviet Union collapse and establishment of the Institute of Geophysical Research (1993) NNC RK (IGR NNC RK), the stations of the Service of Special Control located on the territory of Kazakhstan - Borovoye, Kurchatov, Makanchi, Aktyubinsk - were transferred to the IGR NNC RK. The stations of the Complex Seismological Expedition of IPE AS USSR, one by one, were either transferred to other seismological organizations of Central Asia or closed. But the archive of CSE stations recorded had been stored for a long time in Talgar town, Kazakhstan.

To date, the archive of nuclear explosions records stored at the IGR is as follows:
 Archive of Borovoye station is located at Borovoye station and contains analogue seismograms on paper (since 1961) recorded by RVZT, KSE, SKM instruments, and digital seismograms on magnetic tapes (since 1966). In addition to nuclear explosions records from all Test Sites of the world, the archive contains records of peaceful nuclear explosions (1966 - 1988), large chemical explosions (1965 - 1987), and earthquakes.

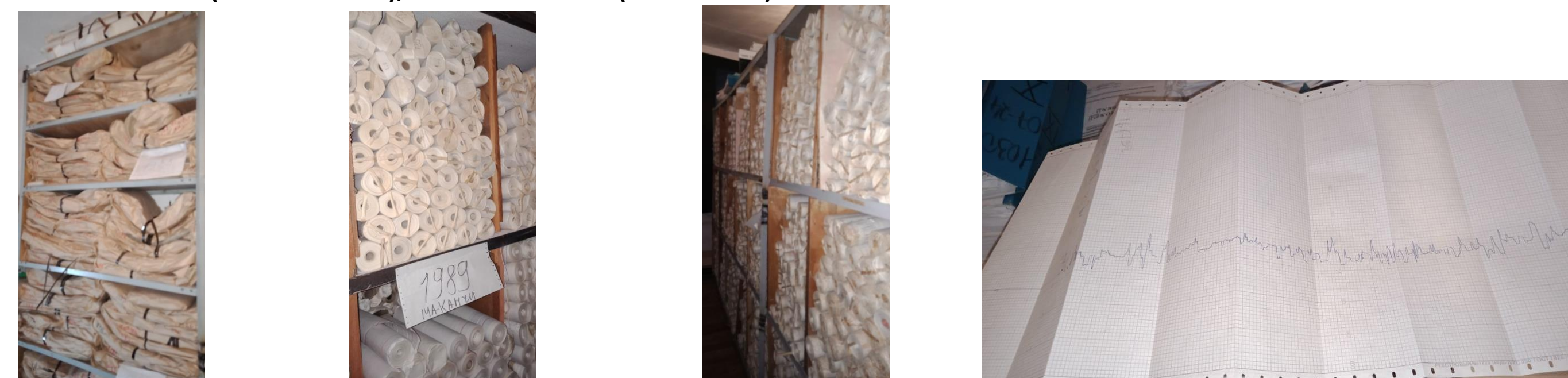


The location of large nuclear Test Sites of Northern Eurasia (stars) and Borovoye seismic station (triangle).



Digitized seismogram of the nuclear explosion conducted at the STS 02/01/1979, t0=04:13:00.2, mb=5.4. Borovoye station.

Archive of Makanchi station. The records of Makanchi station were moved to archive of the IGR in Kurchatov where currently it is stored together with records of "Kurchatov-Cross" seismic array. A lot of explosions records, in Soviet times, were sent to Moscow. Today, the IGR archive in Kurchatov contains photo-paper records of Kurchatov station (1987 - 2002), Novosibirsk station (1987 - 1992), Makanchi station (1992), records of pen-recorders of Makanchi station (1988 - 1993 rr.), Kurchatov station (1987 - 2002).



Archive of Aktyubinsk station is located at the station. It contains records of the station from 1989 to 1993. Some records ~100 - 150 reels together with a folder with main events were sent to the IGR archive in Kurchatov. The archive contains records of nuclear tests from all Test Sites of the world, and records of peaceful nuclear explosions conducted on the territory of the USSR.



Archive of CSE IPE AS USSR stations. In 2015-2016 the archive of CSE IPE RAS was moved to the territory of Kazakhstan National Data Centre of the IGR (KNDC IGR), Almaty. In 2018 the works on the CSE archive forming, arranging and inventory have been started.

The archive of CSE stations contains analogue records of earthquakes (from 1951), nuclear explosions from all Test Sites of the world, records of large chemical explosions (1961 - 1989), peaceful nuclear explosions (1965 - 1988), and records of earthquakes occurred near the Test sites. In total, the CSE archive located at KNDC contains more than 300 000 seismograms.



Thus, the most complete archives on seismic records availability are the archive of Borovoye station (from 1961 to 1990), and archive of CSE at KNDC (from 1951 to 1998).

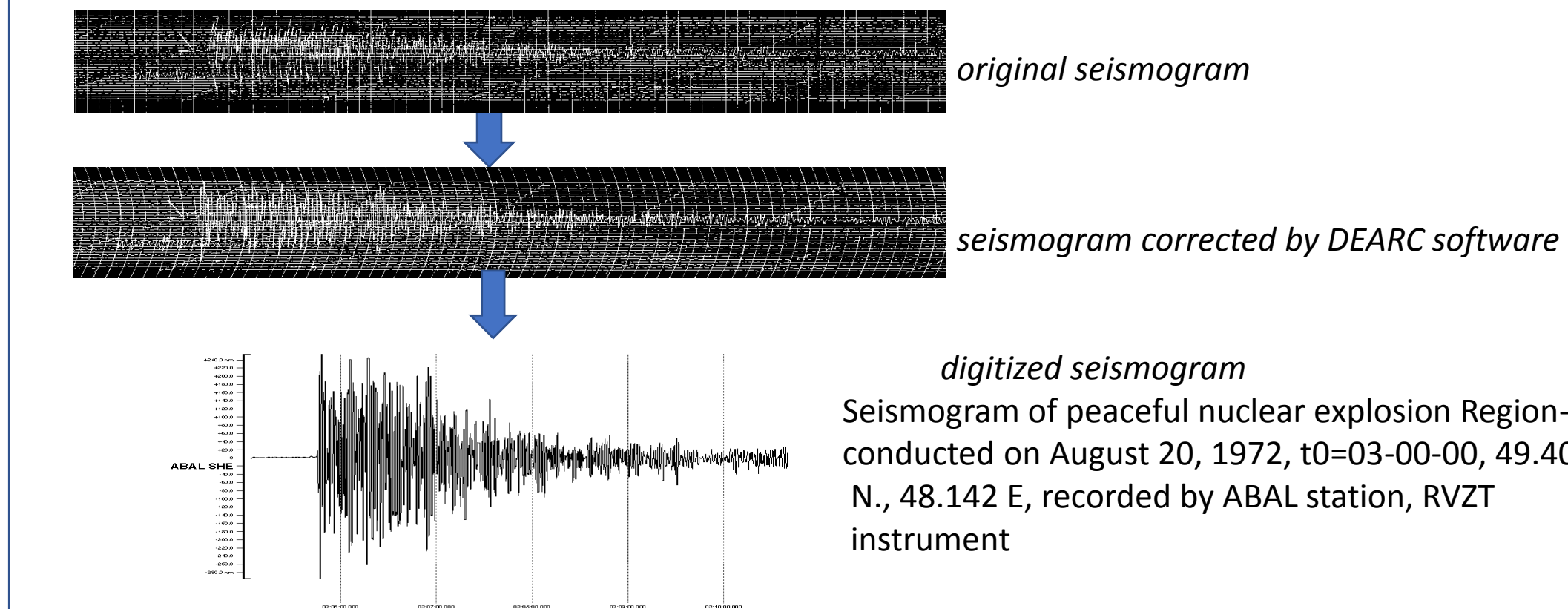
Works on the archive records saving conducted by the IGR

During the past twenty years the Institute of Geophysical Research of RK has been conducting the works on digitizing and scanning of photo- and paper seismograms.

1998 - start of works on nuclear explosions seismograms digitization under the ISTC K-063 Project. The works were conducted at the CSE IPE RAS.

2005 - continuation of works under the budget program "Creation of electron archive of historical seismograms of nuclear explosions and earthquakes recorded by the stations of the Service of Special Control" (2005 - 2011). During this period the IGR staff digitized more than 6000 analogue seismograms of nuclear explosions recorded on photo-paper.

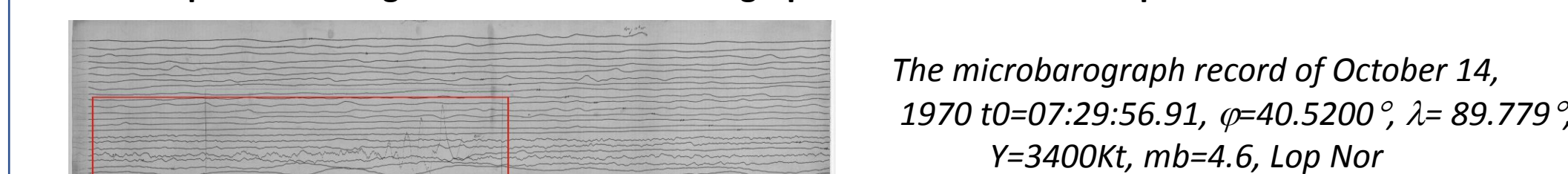
2012 - the works on digitizing are continued under the Project with LDEO. This project was focused on digitizing of curvilinear seismograms recorded by RVZT and KSE instruments, and creating a common database of nuclear explosions seismograms digitized under different projects. The personnel of LDEO developed DEARC software (W.-Y. Kim and M.Gold) that allows correcting the curvilinear seismograms and standardize them.



2013 - under the support of Norwegian seismological agency NORSAR, the wide-format scanner CONTEX HD ULTRA of format 0+, 1200 DPI was purchased. This allowed starting the works on scanning the analog seismograms with high resolution.

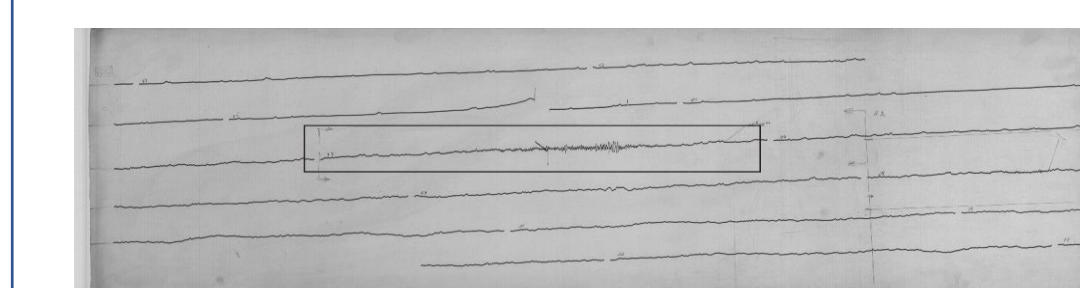
2018 - the works on digitizing of historical records are continued under 2 projects:
 1) *Joint project with AFTAC.* Under this Project it is planned to digitize about 2000 seismograms of nuclear explosions mainly from the Semipalatinsk Test Site region recorded by the stations of the CSE IPE AS USSR that were not digitized before.

It is also planned to digitize the TLG microbarograph records of nuclear explosions.



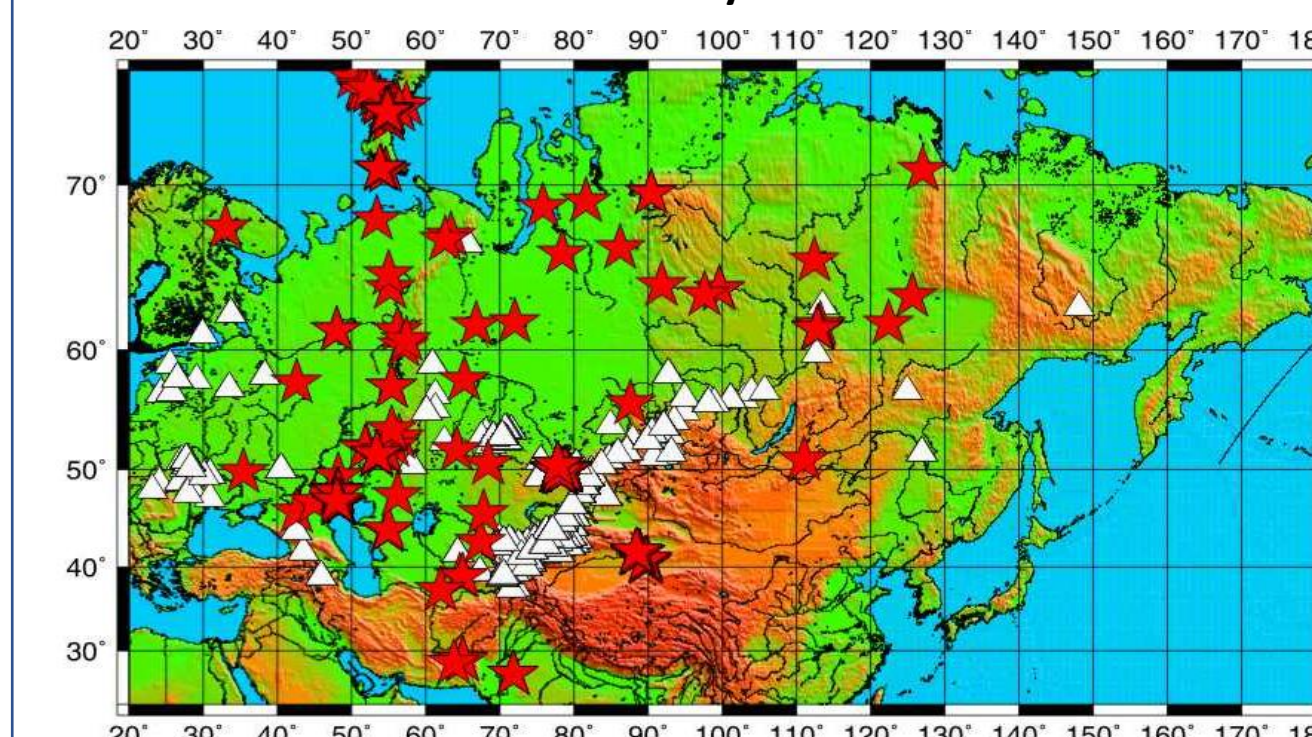
The microbarograph record of October 14, 1970 t0=07:29:56.91, φ=40.5200°, λ=89.779°, Y=3400Kt, mb=4.6, Lop Nor

In addition to seismic records, the archive contains records of microbarograph, strainmeter, and tiltmeter.



The strainmeter record of October 14, 1970 t0=05:59:57.57, φ=73.304, λ=55.027, Y=2200Kt, mb=6.8, Novaya Zemlya.

2) *The ISTC Project "Unified bulletin and seismic hazard assessment of Central Asia territory" (CASHA-BU).* The collaborators are Michigan State University, and LLNL (USA). The project is focused on digitizing paper bulletins using QuakeBase software (developed by Michigan State University), relocation of seismic events occurred on Central Asia territory and seismic hazard assessment.



The map of nuclear explosions location (stars) on the territory of Eurasia, and seismic stations (triangles) seismograms of which were digitized by the IGR.

Thus, under the support of several international and foreign organizations (ISTC, LDEO, NORSAR, AFTAC), and under Kazakhstan award, the IGR has been conducting works on saving historical records of nuclear explosions conducted at different Test Sites of the world. To date, about 10 000 records of nuclear explosions conducted at the Semipalatinsk Test Site, Novaya Zemlya, Lop Nor, Nevada, Amchitka, Mururoa, Fangataufa, in Ekker, Pokharan, and Chagay, as well as peaceful nuclear explosions of the USSR were digitized.

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