CTBT: SCIENCE AND TECHNOLOGY 2017 CONFERENCE

IMPORTANT RESULTS OBTAINED DUE TO NEW SEISMIC ARRAYS INSTALLATION IN KAZAKHSTAN

T1.5-P7

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Summary

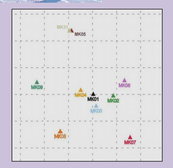
1. History of new seismic arrays installation in Kazakhstan.
2. Regional monitoring of Central Asia earthquakes.
3. Discrimination of seismic sources nature.
4. Detailed analysis of coda wave pattern for regional earthquakes.

Monitoring system

Chronology of seismic arrays installation in Kazakhstan:
1999 - 2000 – primary seismic array PS-23 Makanchi of the IMS;
2001-2002 - auxiliary seismic array AS-057 Borovoye of the IMS;
2001 – Karatayu seismic array (AFTAC);
2004 – Akbulak seismic array (AFTAC);
2006 – auxiliary seismic array AS-058 Kurchatov-Cross of the IMS.

MAKANCHI

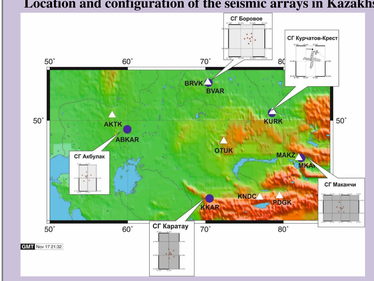
- array configuration – 2 circles (necklace)
- seismometers: 9 one-component vertical and one three-component
- array aperture is 4 km
- Data are transmitted to the IDC (Vienna) and KNDC (Almaty) via the satellite channels

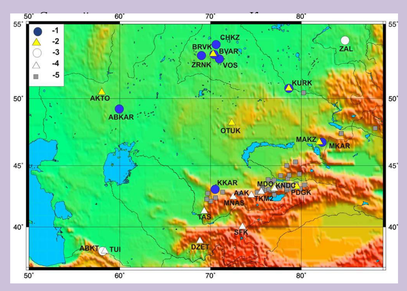


KURCHATOV-CROSS

- Array configuration – cross
- Seismometers: 21 one-component and 1 three-component
- Array aperture is 22.5 km
- Data are transmitted to the IDC (Vienna) and KNDC (Almaty) via the satellite channels

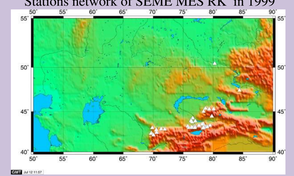
Location and configuration of the seismic arrays in Kazakhstan





1- seismic arrays of the IGR RK; 2- 3-c IGR RK stations;
3- foreign seismic arrays; 4 – foreign 3-c stations;
5 – SEME stations transmitting seismic phases only.

Stations network of SEME MES RK in 1999

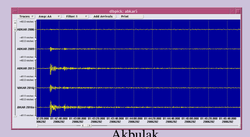


Monitoring results

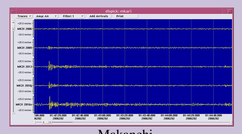
Contribution into the global monitoring via cooperation with International Data Centers

Data from all seismic arrays are transmitted to Kazakhstan National Data Centre (KNDC) in Almaty, and to international Data Centers (IDC, NEIR, ISC, EMSC, GSRAS) where those are used successfully for the global seismic monitoring.

All Kazakhstan arrays have participated in recording and operative processing of seismic records of four nuclear tests conducted by North Korea.



Akbulak

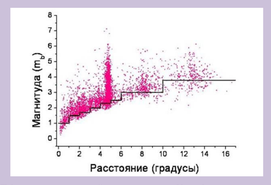


Makanchi

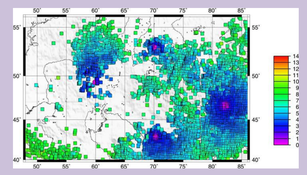
Contribution of seismic arrays data into the regional monitoring of Central Asia

Seismic arrays contribute a lot into the regional seismology of Central Asia as well. Application of seismic arrays data led to obtaining of the following important results and opportunities:
1. Regional monitoring of earthquakes and mining explosions on the territory of Kazakhstan and adjacent Central Asia countries.
2. Revealing of new types of seismic sources and its parameterization.
3. Detailed investigation of wave fields from regional earthquakes to characterize lithosphere heterogeneities in Central Asia.

Operation results of seismic arrays network changed radically the view on seismicity of the whole Kazakhstan territory.
First, new seismically active regions were revealed on the territory that earlier was considered as aseismic according to the current map of general seismic zoning of Kazakhstan.
Second, seismically active regions near the seismic arrays were studied in details.
Third, data on mining explosions are systematized for the whole territory of Kazakhstan.



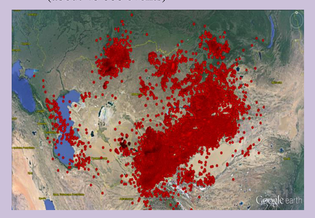
Distance range of events recording by Makanchi seismic array
Red dots – events from operative summary bulletin of KNDC; black line – level of representative magnitudes



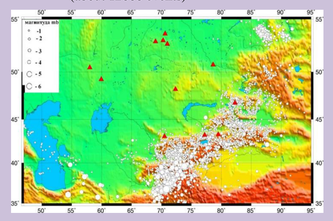
The map of minimal energy classes K of events by data from KNDC interactive seismic bulletin.
Color scale – energy classes.

Seismic events on the territory of Central Asia by KNDC data

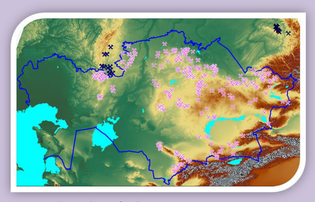
The map of epicenters for two years, 2014 – 2015 (about 40 000 events)



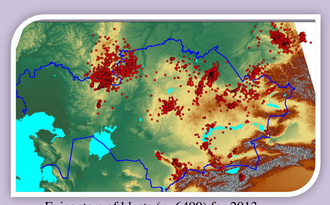
Earthquakes in Central Asia, 2013 (about 12000 events)



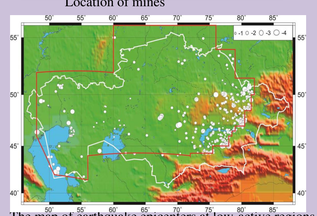
Industrial blasts in total amount of seismic events



Location of mines

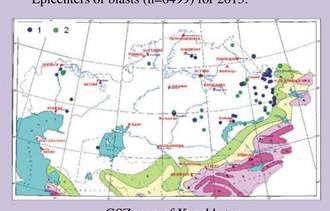


Epicenters of blasts (n=6499) for 2013.



The map of earthquake epicenters at low-active regions from historical time to 2015.

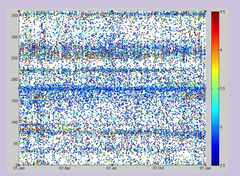
1 - Ms<2;
2- 2 ≤ Ms < 4;
3- 4 ≤ Ms < 5;
4- 5 ≤ Ms



GSZ map of Kazakhstan

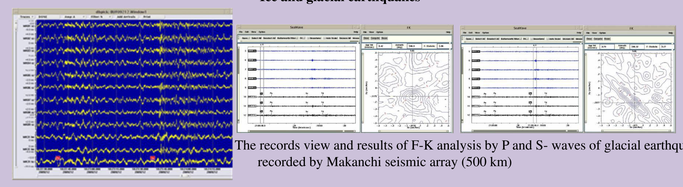
New sources

New types of seismic sources revealed owing to the seismic arrays and its parameterization



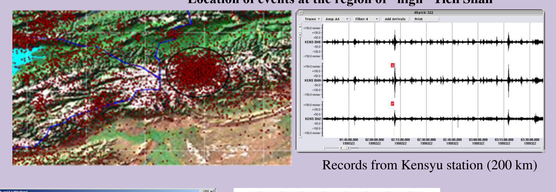
The diagram of seismic signals detection from different azimuths (0 -360 degrees) by Karatayu seismic array for one year.
Color scale – frequency in Hz.

Ice and glacial earthquakes

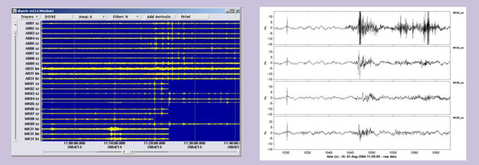


The records view and results of F-K analysis by P and S- waves of glacial earthquakes recorded by Makanchi seismic array (500 km)

Location of events at the region of "high" Tien Shan



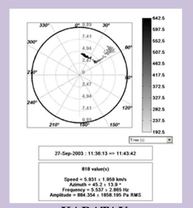
Records from Kensyu station (200 km)



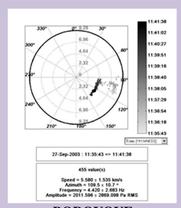
Thunderstorms recorded by seismic arrays Akbulak and Makanchi

Effects in coda of Lg-waves and S-waves of regional earthquakes

Detailed investigation of wave fields from regional earthquakes in study of lithosphere heterogeneities in Central Asia

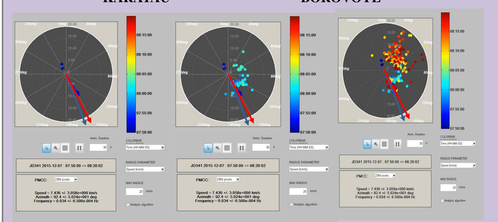


KARATAU



BOROVOYE

The diagrams "velocity – back-azimuth" by the records of Altay (Chyu) earthquake of 2003.



Karatayu seismic array. Earthquake of 2.12.2015, Mw=7.1.
The diagram of "velocity - back-azimuth" detections.
The color shows time (25 minutes in total).

For P-coda – constant back-azimuth, all waves propagate in a plane connecting the epicenter and the array.
For Lg-coda study the results are the following:
Several regimes in coda characteristics in time are observed. Transition regime, when azimuth changes eastward or westward of the direction to a source; asymptotic regime for southern arrays, when most of detections are not related to the direction to the epicenter. This is the difference from traditional interpretation of Lg coda consisting of waves energy coming from random directions.
The character of back-azimuth behavior development depends on mutual location of an earthquake, array and geological blocks.
The lithosphere that influences on waves scattering is heterogeneous in Central Asia. The coda is affected by topography, complex geological structure and distribution of heterogeneities leading to lateral variation of velocity related to attenuation.
The investigations of Lg-coda are continued by French colleagues [Detailed analysis of the far-regional seismic coda in Kazakhstan using array / C. Labonne, O.Sèbe, A.Smirnov, S. Gaffet,Y. Cansi, N. Mikhailova //Bulletin of the Seismological Society of America, Vol. 107, No. 2, pp. –, April 2017, doi: 10.1785/0120160015 BSSA]

Conclusion

Seismic arrays of Kazakhstan play an important role in global monitoring of nuclear tests and earthquakes, and in monitoring of natural and induced seismicity in Kazakhstan and Central Asia that is very important for seismic safety of the region.
Seismic arrays make an invaluable contribution to thorough understanding of regional seismic waves forming, to construction of new models, and investigation of features of crust and mantle structure.