



SEISMIC RISK ASSESSMENT FOR KAZAKHSTAN TERRITORY: STATUS QUO AND WAYS FORWARD

Purpose

Seismic risk mitigation for seismic protection
of Kazakhstan territory and population



Ministry of Education and Science of the Republic of Kazakhstan
RSE «Center for Earth Sciences, Metallurgy and Concentration»
«SEISMOLOGY INSTITUTE»



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SI was founded in 1976 and is a head entity in the area of fundamental and applied research on issues of seismic safety ensuring in the Republic of Kazakhstan

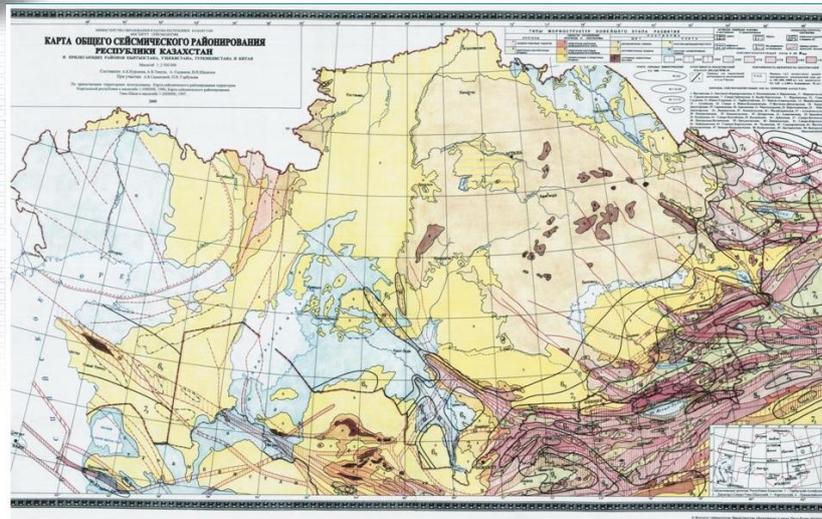


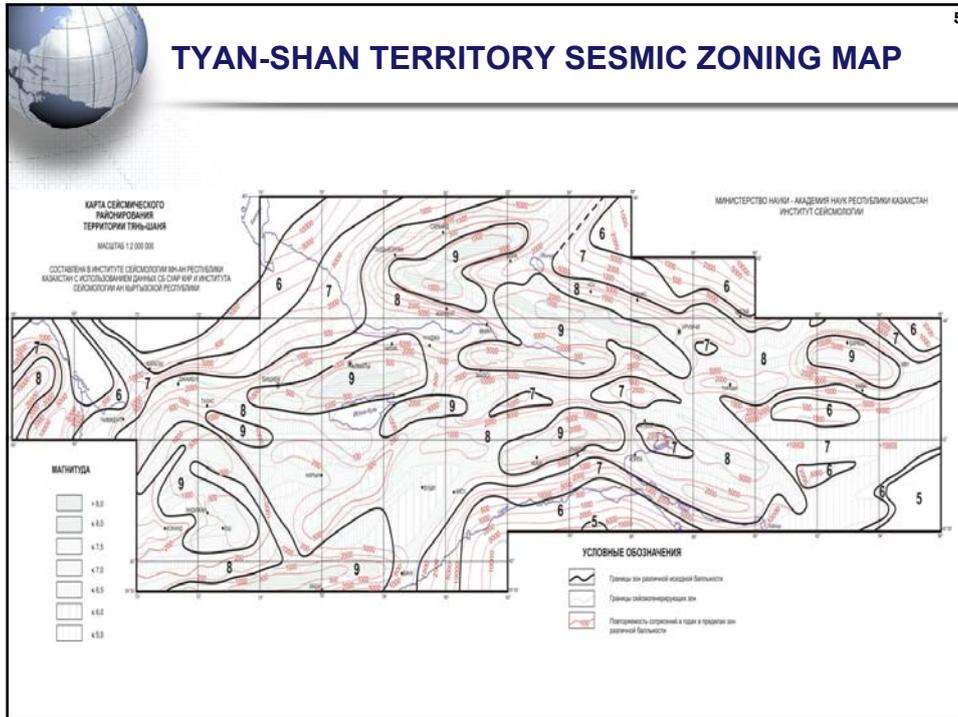
METHODOLOGICAL PRINCIPLES AND APPROACHES TO ADDRESSING THE PROBLEM

- SURVEY OF SEISMIC REGIMENT AND SEISMIC DANGER ASSESSMENT FOR KAZAKHSTAN TERRITORY (general, detailed, and seismic micro-zoning)
- EARTHQUAKE MONITORING AND FORECAST
- SEISMIC RISK ASSESSMENT OF SETTLEMENTS AND OBJECTS OF SPECIFIC IMPORTANCE, EARTHQUAKE DAMAGE FORECAST



MAP OF GENERAL SEISMIC ZONING OF THE REPUBLIC OF KAZAKHSTAN





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EARTHQUAKE MONITORING AND FORECAST

Seismic Forecast Classification and Tasks

- **Currently three types of forecasts are prepared by Seismological Services for the authorized bodies of the RK:**
- **Long-term (2-10 years) – detection of forming zones of future earthquake epicenters.**
- **Mid-term (1-2 years) – forecast of degree of seismic danger for zones detected under the long-term forecast.**
- **Short-term (1-30 days) – forecast and evaluation of parameters of expected seismic activities in zones detected under long- and mid-term forecasts.**



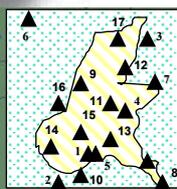
REPUBLICAN SYSTEM OF SEISMOLOGICAL MONITORING AND EARTHQUAKE FORECAST

Seismological Monitoring System comprises:

- 60 monitoring stations including 50 seismic stations;
- network of seismic stations of the National Nuclear Center of the RK.

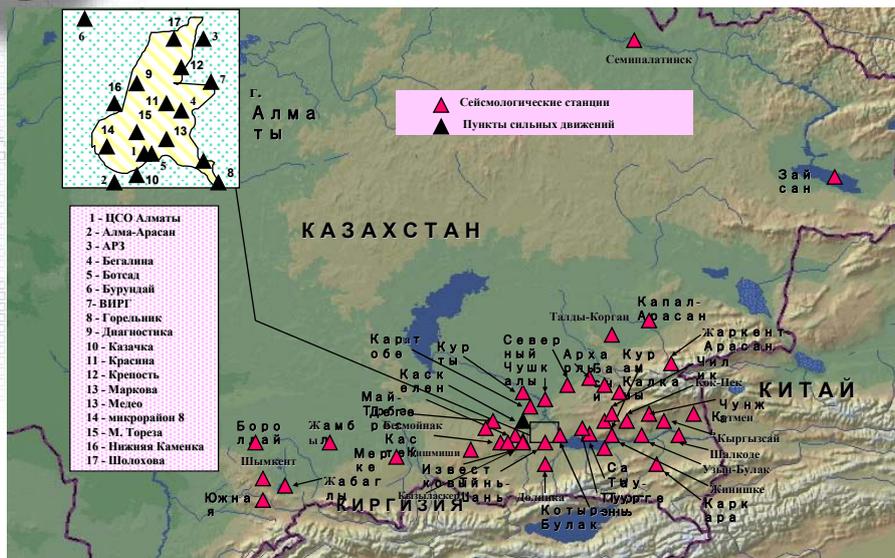


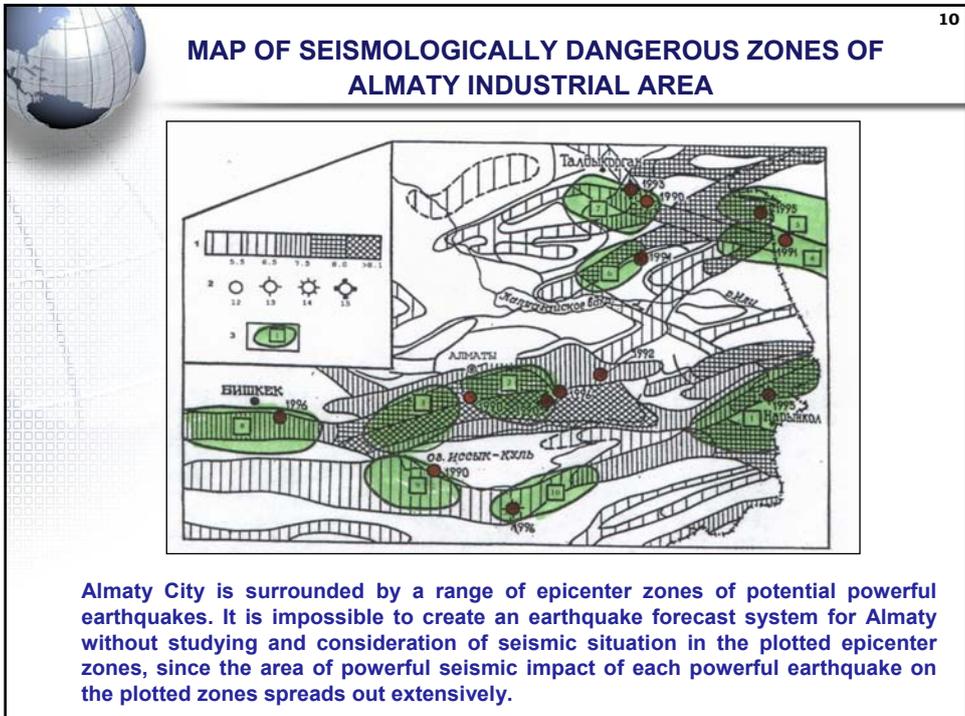
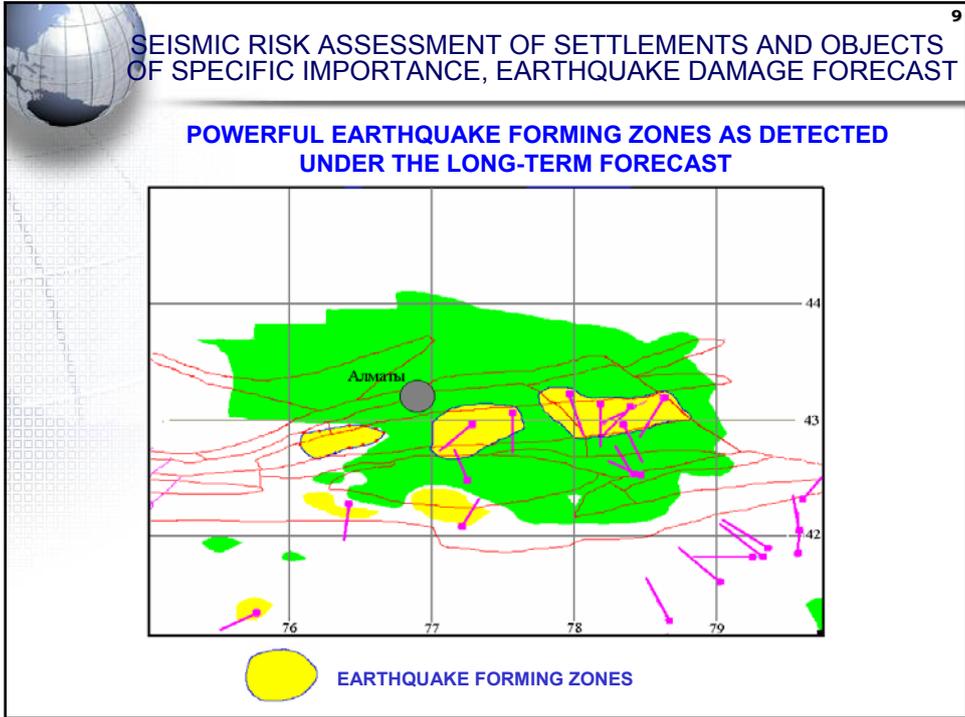
SEISMOLOGICAL MONITORING SYSTEM



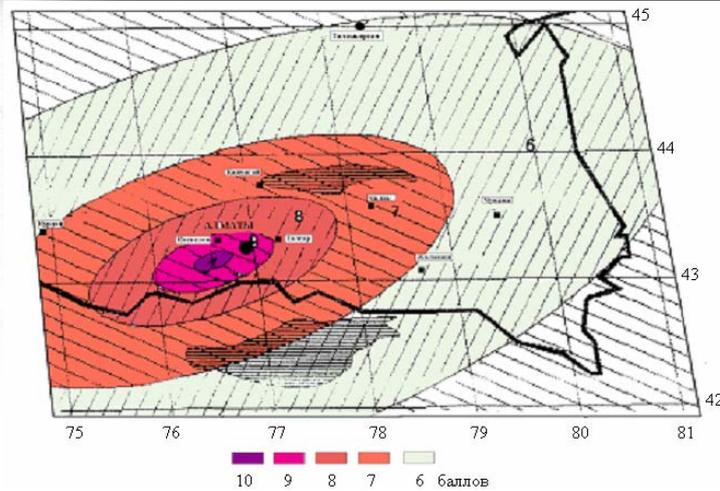
- 1 - ЦСО Алматы
- 2 - Алма-Арасан
- 3 - АРЗ
- 4 - Бегалина
- 5 - Ботсал
- 6 - Бурундай
- 7 - ВИРГ
- 8 - Горельник
- 9 - Диагностика
- 10 - Казачка
- 11 - Красина
- 12 - Крепость
- 13 - Маркова
- 14 - Мелео
- 15 - микрорайон 8
- 16 - М. Тореза
- 17 - Шолохова

▲ Сейсмологические станции
▲ Пункты сильных движений



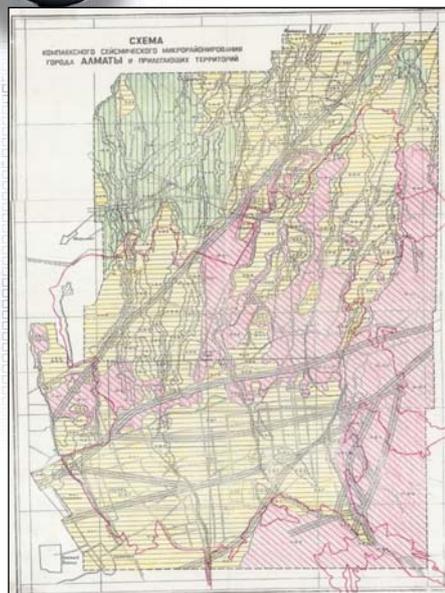


SAMPLE FORECAST OF SEISMIC IMPACT FOR ALMATY CITY IN CASE OF A POWERFUL EARTHQUAKE IN KEMINSKY ZONE



Seismic effect of a powerful earthquake with an epicenter in Keminsky zone (40-60 km from the city) to Almaty City will result in magnitude 9 earthquake of the city territory.

MAP OF SEISMIC MICRO-ZONING OF ALMATY CITY



The Map was developed in 1995 based on PCH-10-83 put in effect in 1983.

The Map needs an update as in the course of its development spectral characteristics of possible soil oscillations were not considered, joint fissure zones' width and impact zones of such to economic objects were not identified.

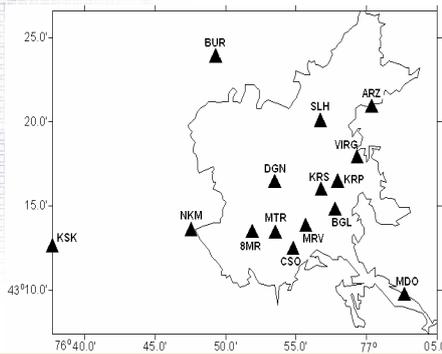
All the latter represent main basis for registration of resonance conditions in the "soil-construction" system.



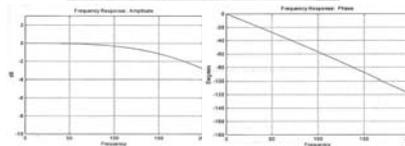
NETWORK OF STATIONS OF POWERFUL MOVEMENTS

There are strong reasons for creation of a new Seismic Micro-Zoning Map (SMZ Map).

Digital network comprising 15 sets of wide dynamic range digital accelerographs "ALTUS-ETNA" has been operating in the city and outskirts since 2000/ the devices are installed in ground-floor facilities of buildings on special free-standing pedestals and function in trigger-mode with three-component registration.



Network of digital stations of powerful movements in Almaty City



Outward of "ALTUS-ETNA" accelerograph, its amplitude and phase characteristics.

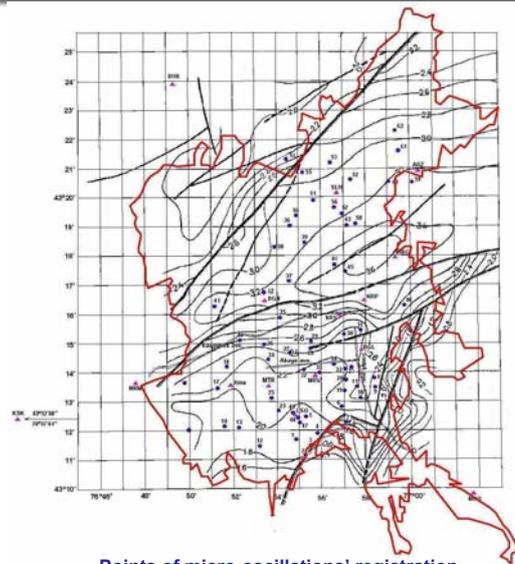


MICRO-OSCILLATIONS' MONITORING



SL-3 Registering device

- ▲ Powerful movement stations
- Additional points of micro-oscillations' registration
- Faults
- 2.8 - Paleozoic fundament depth



Points of micro-oscillations' registration



TO DEVELOP THE SMZ-MAP FOR ALMATY BASED ON NEW METHODOLOGY IT IS NECESSARY TO:

- Create parametrical models of sedimentary cover (velocity, plane, density, engineering-geological, and physical-mechanical parameters of soils).
- Develop a groundwater level model taking into consideration its seasonal fluctuations.
- Map seismic characteristics of sedimentary cover soils based on processing of micro-oscillation registration data in dense settlement network (~ 500 m x 500 m) with condensation in active fault zones.
- Map zones of currently active tectonic faults (verification of location and width) within the city based of soil gas composition survey, micro-oscillation records, geoelectrical prospecting and shaft-sinking works (drilling, shafts, channels).
- Map soil oscillation frequency characteristics based on micro-oscillation records and calculations taking into consideration the overall capacity of sedimentary cover and records of the powerful movement stations.
- Develop seismic impact models for the set of above mentioned works.

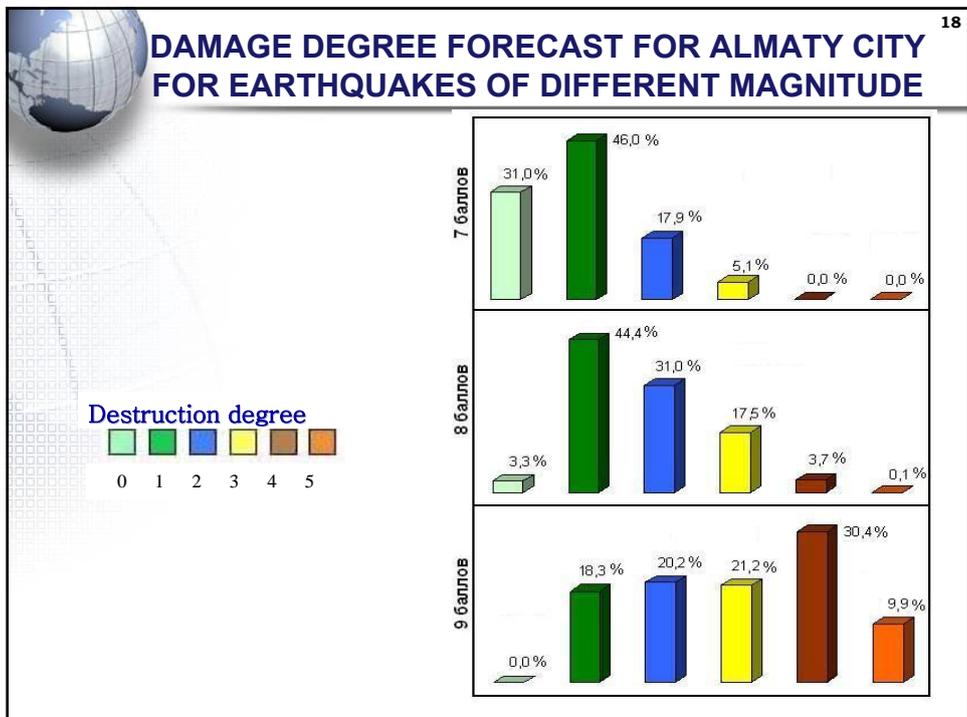
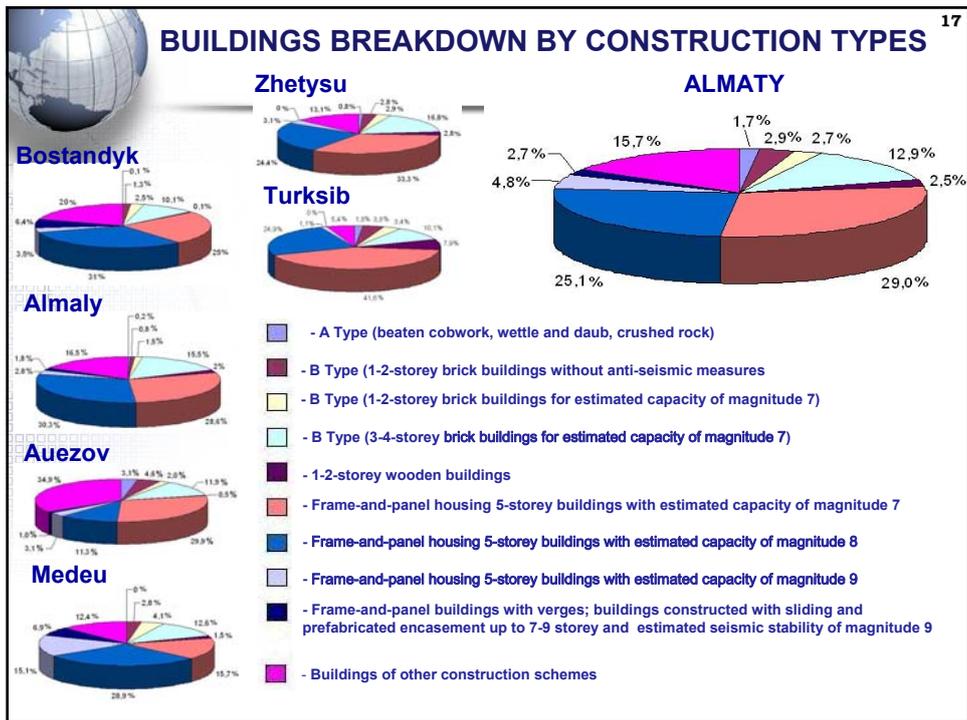


SEISMIC RISK ASSESSMENT FOR ALMATY CITY

Seismic risk is a possibility of social and economic damage associated with an earthquake at the selected territory within a certain timeframe

Summary Data on the number of surveyed multi-storey housing buildings, number of residents and total footage in Almaty City

District Name	Number of Buildings	Number of Residents (Data – from HOC)	Quakeproof		Non-quakeproof		To be surveyed	
			Number of Buildings	Total footage, M ²	Number of Buildings	Total footage, M ²	Number of Buildings	Total footage, M ²
Bostandyk	1,745	102,319	892	344,198.5	519	784,036	334	128,790.4
Almaly	847	72,138	300	224,729.5	343	624,764.8	204	78,662.4
Auezov	3,587	157,412	1,665	270,852	1,192	1,118,152	729	281,102.4
Medeu	1,304	58,192	757	145,556.9	374	493,268	173	66,708.8
Zhetysu	649	30,889	360	72,990.8	126	239,464.7	163	62,852.8
Turksib	3,182	82,103	2,175	304,796.8	755	531,438.3	233	89,844.8
Total for Almaty	11,294	503,053	6,149	1,363,124.5	3,309	3,791,123.8	1,836	707,972.4

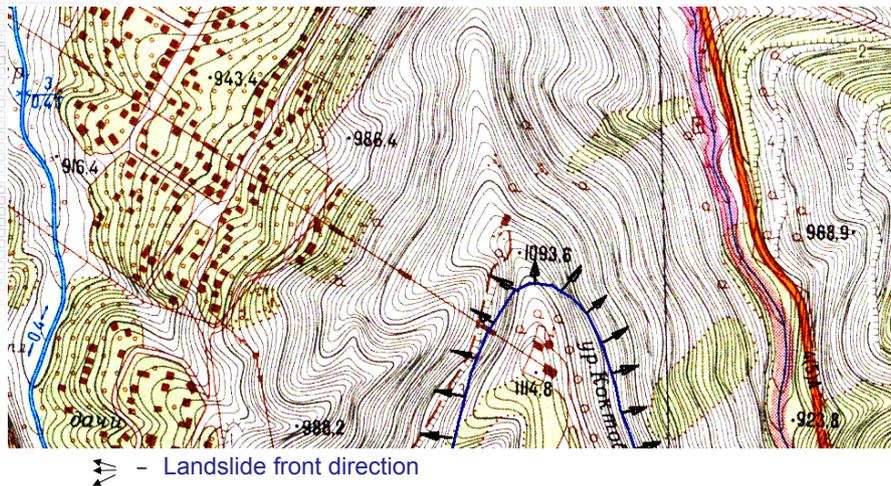




POTENTIAL SEISMIC-CAUSED LANDSLIDE ON NW FLANK OF KOKTOBE HILL

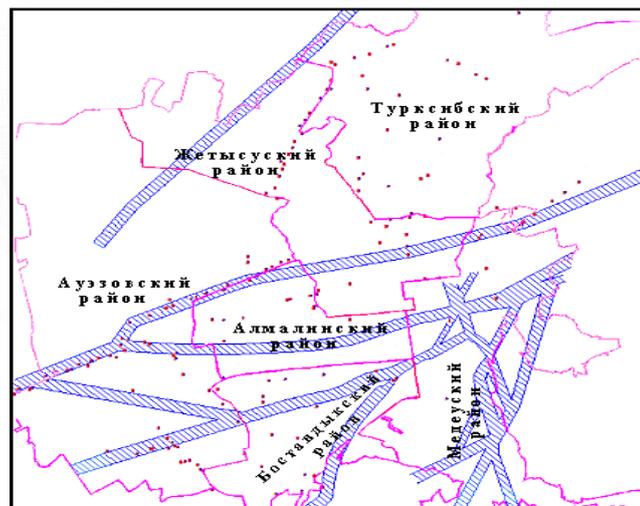
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Detected cracks and soil draws are currently suspended by fortification arrangements, nevertheless, the slide is possible in case of an earthquake



POTENTIAL FIRE EPICENTERS IN ALMATY CITY

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- - network of gas-stations, which represent potential fire sources
- ▨ - tectonic faults' scheme

LOCATION OF OIL, OIL-GAS AND GAS FIELDS IN THE REPUBLIC OF KAZAKHSTAN

РАСПОЛОЖЕНИЕ НЕФТЯНЫХ, НЕФТЕГАЗОВЫХ И ГАЗОВЫХ МЕСТОРОЖДЕНИЙ РЕСПУБЛИКИ КАЗАХСТАН



SAMPLES OF MAN-CAUSED SEISMICITY AFTER CONTINUOUS DEVELOPMENT OF HYDROCARBON FIELDS

- **Gazky, Uzbekistan, 1976 (M=7,0), 1984 (M=7,4) 14 years**
- **Kumdag, Western Turkemistan, 1986 (M=6,0) 20 years**
- **Neftegorsk, North Sakhalin, 1995 (M=6,8) 30 years**



NEGATIVE PROCESSES CAUSED BY MINERAL DEVELOPMENT

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Geo-dynamical processes

- Surface Deformation
- Surface faults' Formation
- Upheaval

Emergency Situations

- Man-caused Emergencies
- Fires
- Destruction of Buildings and Communications
- Environmental Pollutions



ENVIRONMENTAL IMPACT OF EARTHQUAKES

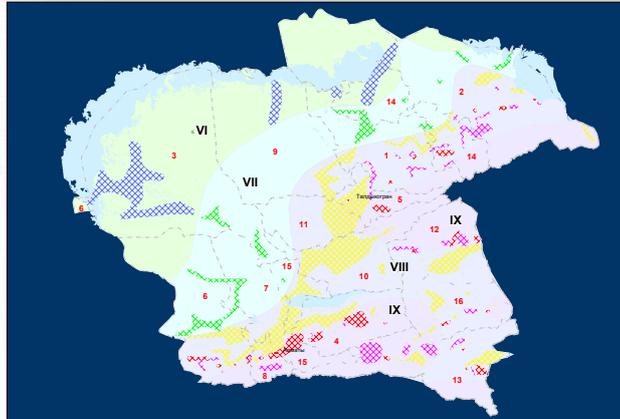
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Chilik Fault



- Relief transgression,
- Spills,
- Thrusts,
- Seismogenic slides,
- Avalanches,
- River blockage
- Man-caused emergencies,
- Fires,
- Disturbance of communications
- Environment pollution

ALMATY OBLAST RISK ZONES



-  I category – magnitude VIII - IX, secondary factors, settlements of category 1-2
-  II category – magnitude VIII - IX, secondary factors, settlements of category 3-4
-  III category – magnitude VIII - IX, no secondary factors, settlements of category 1-4
-  IV category – magnitude VII, no secondary factors, settlements of 1-4
-  V category – magnitude VI and lower, no secondary factors, settlements of category 1-4

ALMATY OBLAST

I risk category zones (earthquakes of magnitude 8-9 and higher, secondary factors, settlements of category 1-2) are located on the foothill plains of Zaili and Jungar Alatau within Karasai, Talgar, Panfilov, Aksu, and Sarkand Regions with settlements of 4,000 and more population and number of economic entities of 1,000 and more.

II risk category zones (earthquakes of magnitude 8-9, secondary factors, settlements of category 3-4) are located within the territories of Karasai, Raiymnek, Uigur, Panfilov, Aksu, Sarkand, and Alakol Regions with settlements of 2,000 - 4,000 population and number of economic entities of 500 - 1,000.

III risk category zones (earthquakes of magnitude 8-9, secondary factors, settlements of category 1-4) – Enbekshikazakh, Karasai, Ili, Jambyl, Raiymnek, Uigur, Panfilov, Kerbulak, Koksu, Karatal, Aksu, and Alakol Regions with settlements of 500 - 2,000 population and number of economic entities of 100 - 500.

IV risk category zones (earthquakes of magnitude 7, settlements of category 1-4) – Jambyl, Balkhash, Aksu, Sarkand, and Alakol Regions with settlements of mainly 500 population and less than 100 economic entities.

V risk category zones (earthquakes of magnitude 6 and lower, settlements of category 1-4) – Balkhash, Karatal, and Sarkand Regions with settlements of mainly less than 500 population and less than 100 economic entities.

ALMATY CITY RISK ZONES



I risk category – Bostandyk District. Despite of the smallest number of vulnerable buildings, other social and economic indicators and seismicity of magnitude 10 provide for the highest integral risk category.

II risk category - Almaty District. Less dangerous seismic situation is compensated by significant potential losses at the expense of social and economic factors.

III category – Zhetysu, Auezov, and Medeu Districts

IV risk category – Turksib District (lower business activity, high vulnerability of buildings (mainly private sector) are compensated by significant decrease of seismicity - magnitude 8.

RECOMMENDATIONS FOR INCREASED EFFECTIVENESS OF ASSESSMENT AND CREATION OF SEISMIC RISK MANAGEMENT SYSTEM

- **Seismic Danger**
Soil oscillations; Soil thinning-out; Fires; Landslides and avalanches
- **Risk Vulnerability of**
Infrastructure; Population; Economy; Social and Political System
- **Vulnerability of**
Infrastructure; Population; Economy; Social and Political System
- **External Connections**
Economical; Transport; Political; Cultural
- **Capability of Quick Response and rehabilitation**
Planning; resources available after the earthquake; Mobility and access to the city after the earthquake



Thank you for your attention!