ANSO-MAS 2026: The 2nd Conference on Environmental Hazards in Asia - Building Resilience to Future Hazards

SOUTHERN BAIKAL EARTHQUAKE OF OCTOBER 14, 2022 (MW 5.4): MACROSEISMIC OBSERVATIONS AND INTENSITY PATTERNS

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Ulaanbaatar, Mongolia - July 28-30th 2026

Southern Baikal earthquake of October 14, 2022 (Mw 5.4)

It is of significant interest for several reasons:

First – it was widely felt across a huge territory, caused significant public concern, and even produced minor building damage in the near zone.

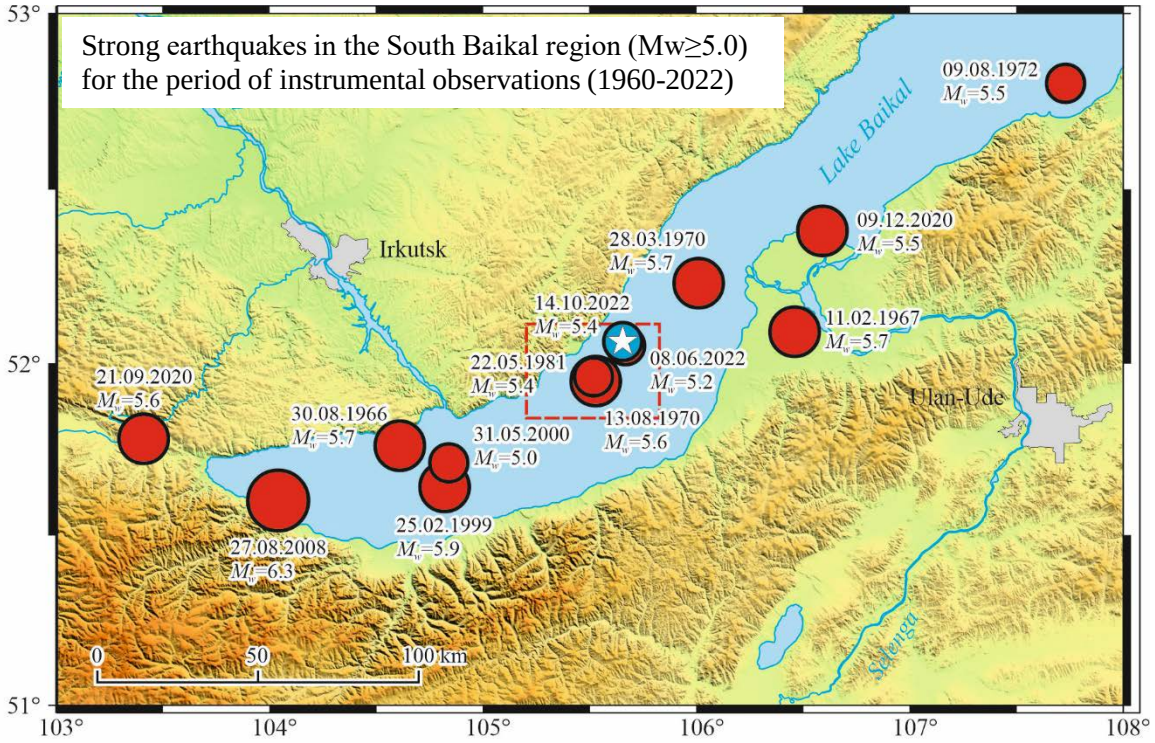
Second – it can be considered as part of a series of strong seismic events in the Baikal Rift Zone in 2020-2022, which included significant earthquakes such as

Significant events of 2020-2022

Bystraya eathquake (21.09.2020, Mw=5.6) *[Filippova et al., 2022; Radziminovich et al., 2024],*

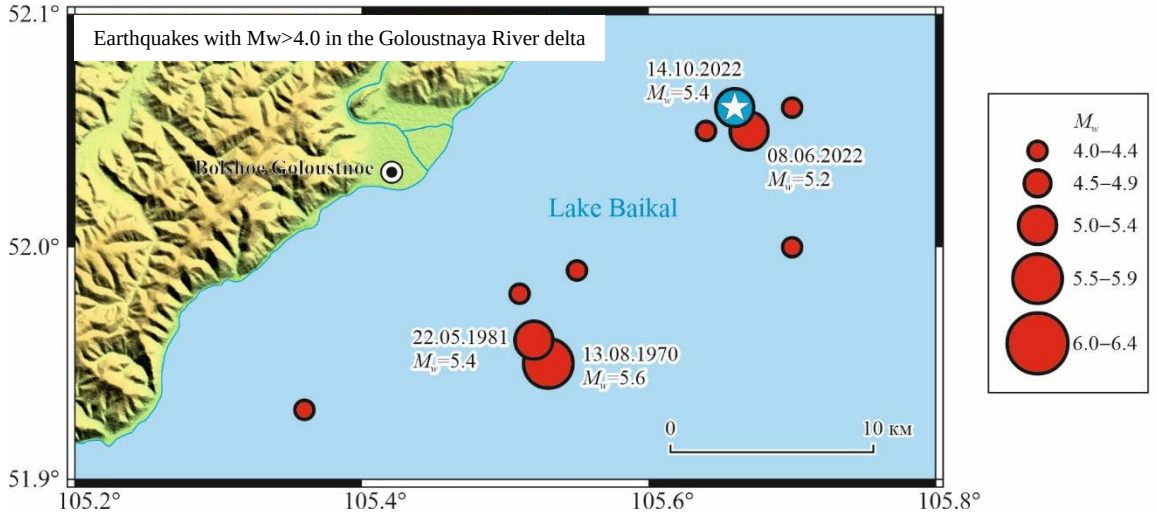
Kudara earthquake (09.12.2020, Mw=5.5) *[Tubanov et al., 2021; Radziminovich et al., 2022]*

Khuvsgul eathquake (11.01.2021, Mw=6.8) *[Emanov et al., 2022]*



Third – the earthquake of 14.10.2022 occurred at almost the same point as the event of 08.06.2022 (Mw=5.2) [*Radziminovich et al., 2023a; Ochirova, Radziminovich, 2025*], as well as very close to the epicenter of the earthquake of 22.05.1981 (Mw=5.4) [*Golenetsky et al., 1984*].

Date	Time	Coordinates		Depth (km)	Magnitude			K_P
		Lat (^{0}N)	Lon (^{0}E)		M_W	*mb*	*MS*	
22.05.1981	09:51:20.5	51.96	105.52	28±1.5*	5.4	5.2	5.4	14.0
08.06.2022	12:24:19.7	52.05	105.67	22±2	5.2	5.1	5.1	14.2
14.10.2022	00:53:54.2	52.06	105.66	19±2	5.4	4.9	5.3	14.0



* – depth is given according to the ISC-EHB project [*Engdahl et al., 1998, 2020*]. Magnitudes M_W are based on data from GCMT (The Global CMT Project, Lamont Doherty Earth Observatory, Columbia University, USA, http://www.globalcmt.org); magnitudes *mb* и *MS* – according to ISC (International Seismological Centre, Great Britain, http://www.isc.ac.uk). All other parameters are given according to the data of the Baikal branch of the FRC GS RAS.

Location of the epicenter near the village Bolshoe Goloustnoye and the presence of two previous closely spaced events (22/05/1981 and 08/06/2022) give reason to name the earthquake on 14/10/2022 –

GOLOUSTNAYA-III EARTHQUAKE

DATA

Online questionnaires	Baikal branch of the Federal Research Center (2008)
	Dobretsov Geological Institute of SB RAS together with Buryat branch of the Federal Research Center (2020)
Backup questionnaire using Google Forms	Baikal branch of the Federal Research Center (2022)
	Dobretsov Geological Institute of SB RAS together with Buryat branch of the Federal Research Center (2020)
Email requests to local administrations	less than 2% of all responses
Regional seismic station staff	a few reports

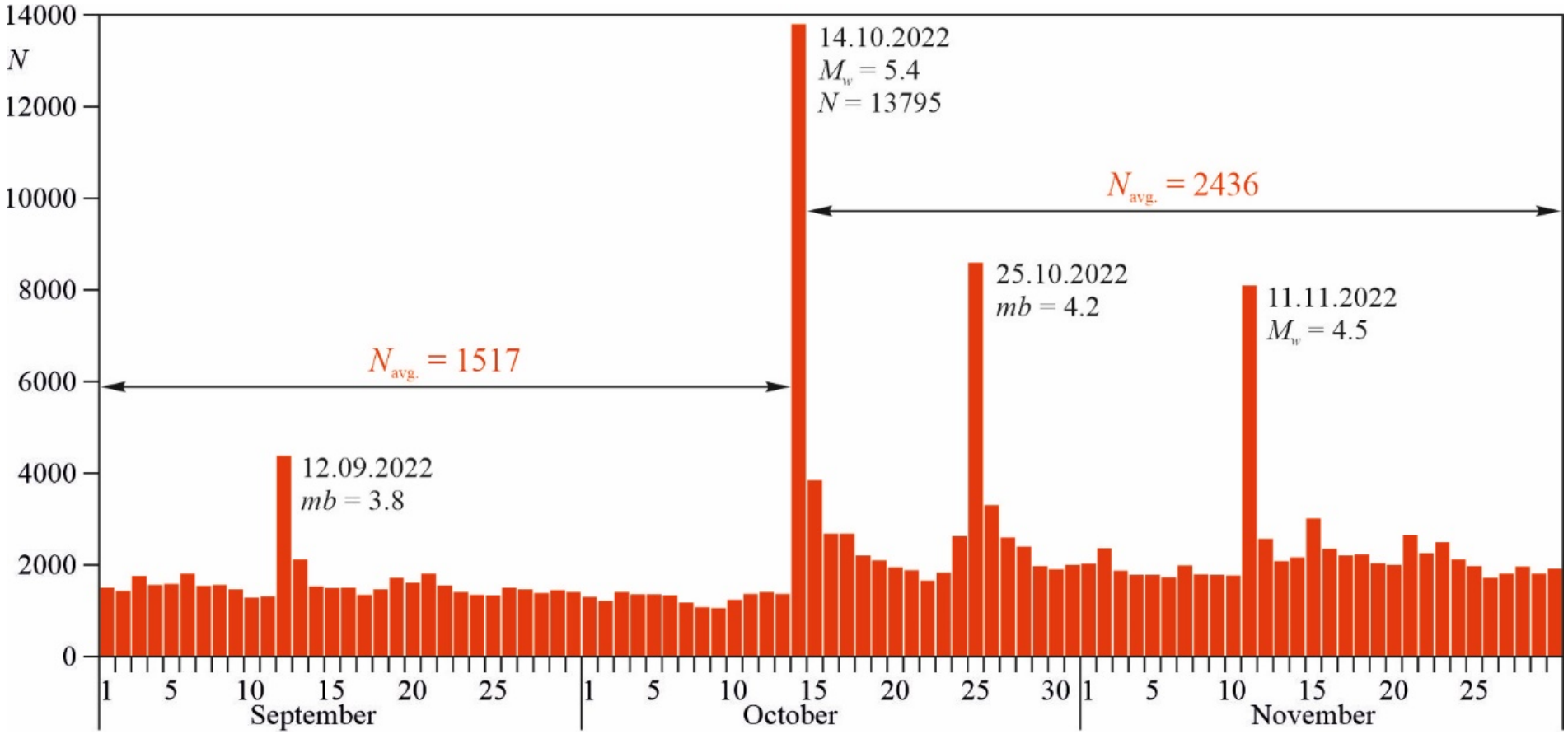
All intensity estimates were made using the MSK-64 scale [*Medvedev et al..*, 1965]

Online questionnaires are not new. Start from the USGS "Did You Feel It?" system to European networks [*Wald et al.*, 1999, 2011; *De Rubeis et al.*, 2009; *Sbarra et al.*, 2010; *Bossu et al.*, 2017; *Goded et al.*, 2017; *Quitoriano, Wald*, 2020].

In Siberia, we have been using this method since 2008, and the Buryat branch joined in 2020 and proved its effectiveness [*Tubanov et al.., 2021; Ochirova, Radziminovich, 2025*].

PUBLIC RESPONSE

The number of daily visits (N) to the website of the Baikal branch of the FRC GS RAS for the period September–November 2022 (https://seis-bykl.ru)



The individual pronounced peaks on the histogram correspond to noticeable earthquakes.

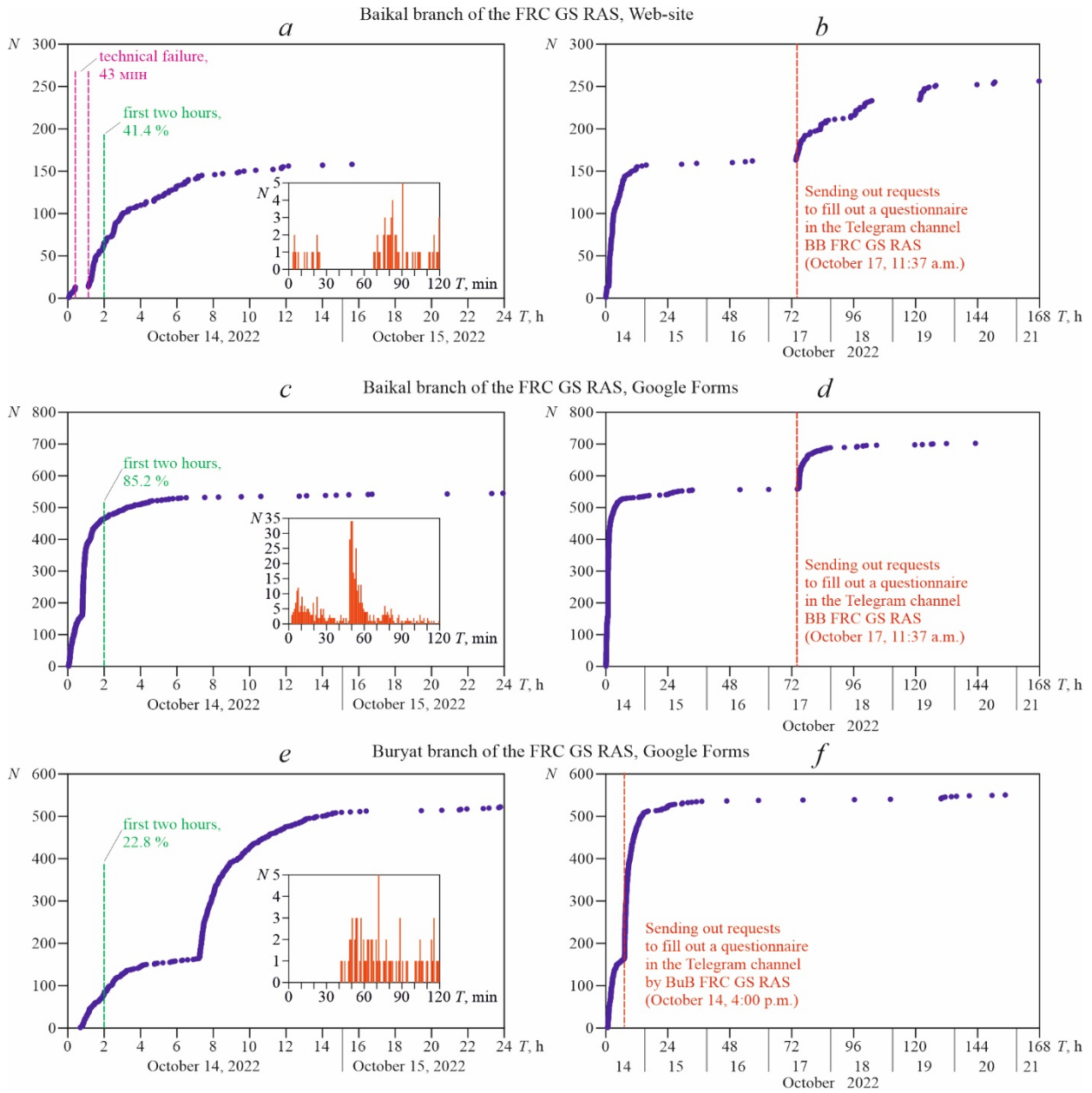
DATA COLLECTION DYNAMICS

In the first 24 hours:

Baikal branch website:
157 responses
(**41.4**% within two hours,
≤5 responses/min)

Baikal branch
backup Google Forms:
541 responses
(**85.2**% within two hours,
34 responses/min)

Buryat branch Google Forms:
355 responses



Baikal branch of the Federal Research Center:

Main site
- **270** responses

Baikal branch of the Federal Research Center:

Backup questionnaire using Google Forms
- **728** responses

Dobretsov Geological Institute of SB RAS together with Buryat branch of the Federal Research Center:

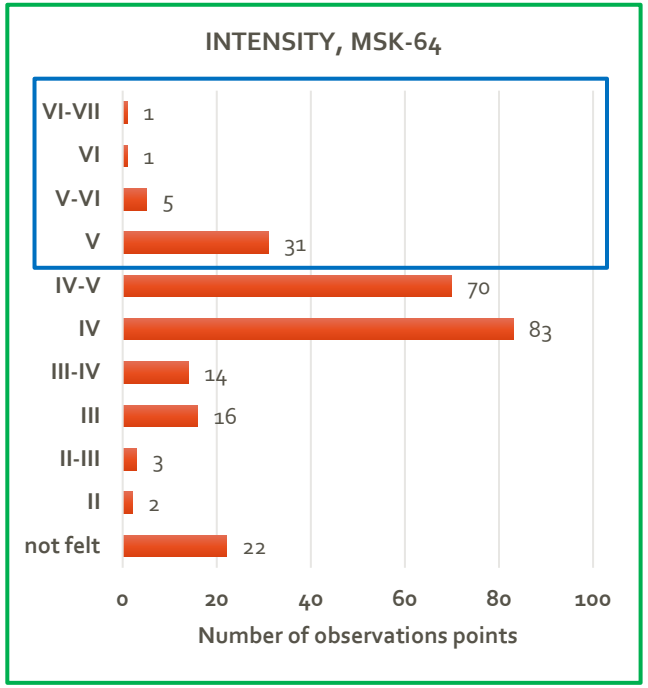
Google forms - **539** responses

Macroseismic data on the Goloustnaya-III earthquake 14.10.2022

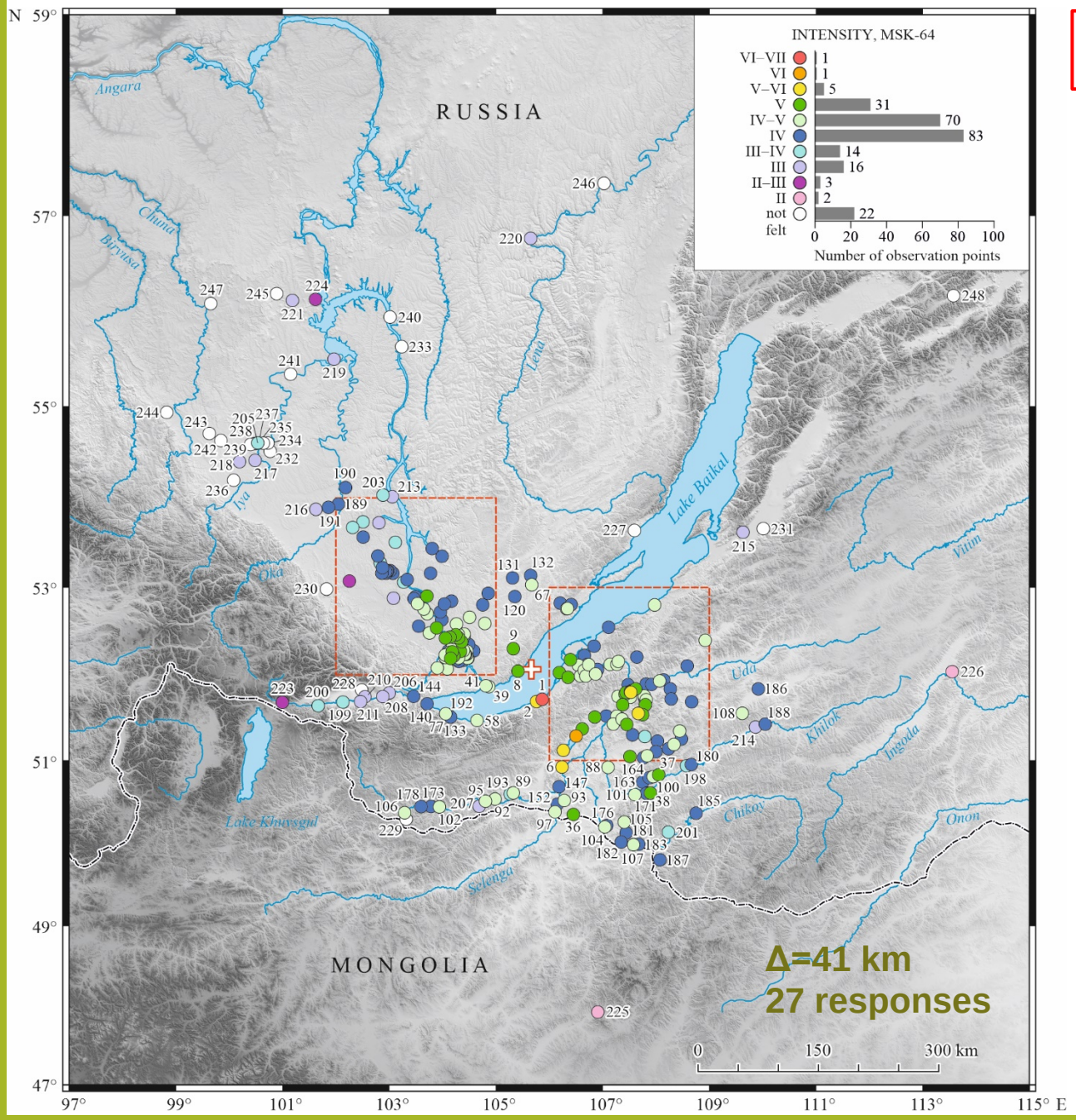
№	Locality	Coordinates		Δ, km	number of questionnaires	I, MSK-64
		LAT	LON			
1	Babushkin	51.712	105.865	41	27	VI–VII
2	**Gusinoozersk**	**51.283**	**106.500**	**104**	**79**	**VI**
3	Klyuyevka	51.688	105.758	42	3	V–VI
4	Gusinoye Ozero	51.114	106.261	113	1	V–VI
5	DNP Rubin	51.794	107.526	131	1	V–VI
6	Selenduma	50.917	106.236	133	1	V–VI
7	Nadeino	51.548	107.666	149	1	V–VI
8	Bolshoye Goloustnoye	52.040	105.410	17	3	V
9	Maloye Goloustnoye	52.299	105.323	35	2	V
10	Posolskoye	52.022	106.186	36	1	V
11	Posol'skaya st.	51.968	106.350	48	1	V
12	Stepnoy Dvorets	52.172	106.395	52	2	V
13	**Irkutsk**	**52.267**	**104.333**	**93**	**563**	**V**
14	HNP Eksperimental niy	52.378	104.355	96	1	V
15	Markova uts.	52.216	104.210	100	29	V
16	Karluk	52.423	104.297	101	7	V
17	Tohoiy	51.367	106.617	101	2	V
18	Khargana	51.506	106.852	102	1	V
19	HNP Cheremushki	52.263	104.177	103	2	V
20	HNP Belochka	52.185	104.151	104	1	V
21	Urik	52.458	104.246	106	6	V
22	Ust'-Kuda	52.431	104.137	111	11	V
23	Meget	52.420	104.053	116	3	V
24	Nizhnyaya Ivolga	51.772	107.420	125	1	V
25	Khoytobeye	51.790	107.434	125	1	V
26	Kolobki	51.650	107.373	126	1	V
27	DNP Prigorodnoye	51.803	107.516	130	1	V
28	**Angarsk**	**52.537**	**103.886**	**132**	**69**	**V**
29	Poselye (Ivolginsky District)	51.806	107.538	132	2	V
30	**Ulan-Ude**	**51.833**	**107.617**	**136**	**198**	**V**
31	Desyatnikovo	51.418	107.450	142	2	V
32	Nikolaevskiy	51.650	107.800	154	2	V
33	Kuytun	51.533	107.750	155	1	V
34	Olonki	52.899	103.704	162	1	V
35	Kugoty	51.041	107.510	171	1	V
36	**Kyakhta**	**50.351**	**106.449**	**197**	**43**	**V**
37	Amagalantuy	50.825	108.051	215	1	V
38	Poselye (Bichursky District)	50.609	107.894	223	1	V

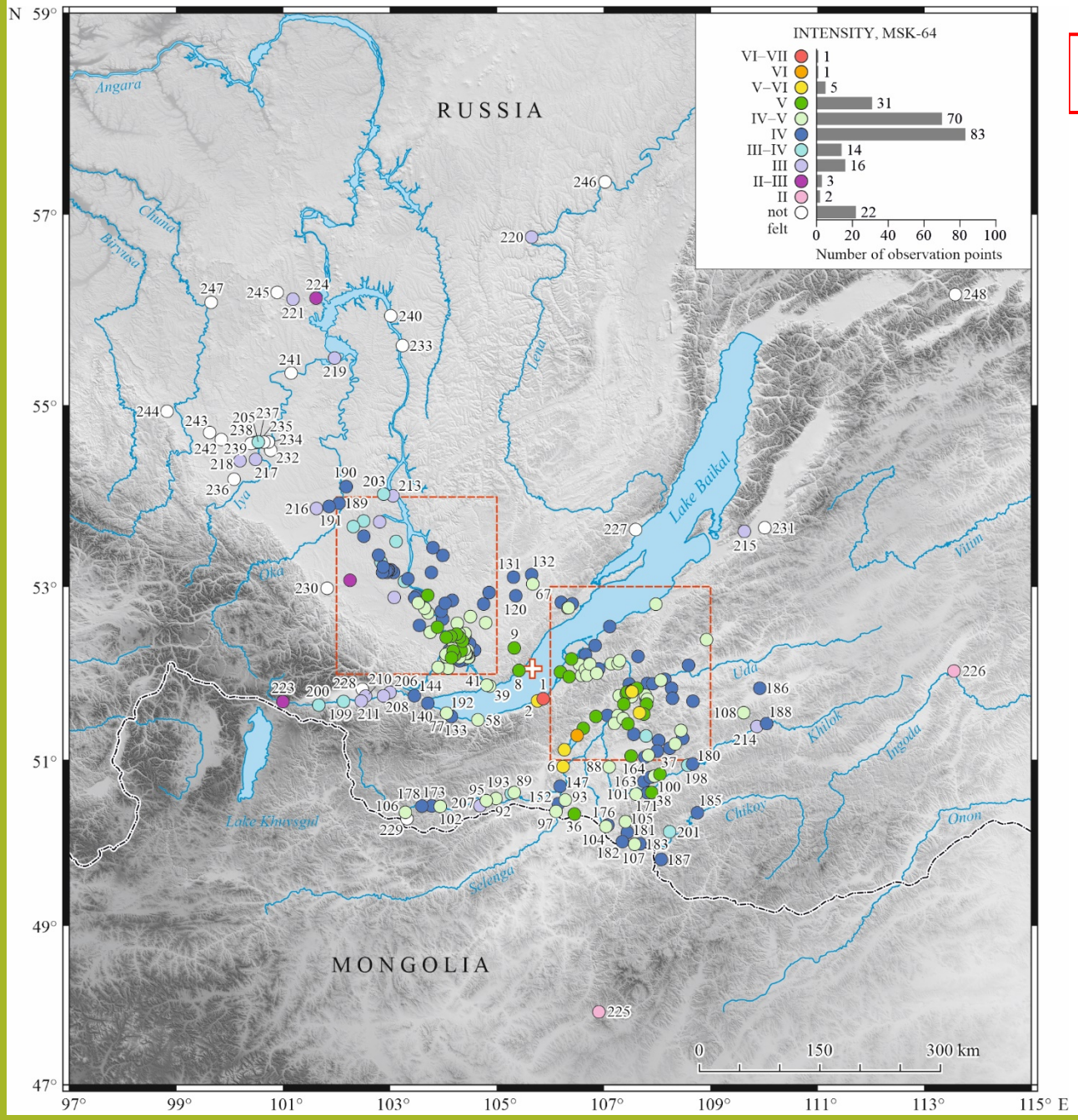
Taking into account all the information collected and suitable for processing, it became possible to estimate the intensity of shaking (or to document the absence of macroseismic effects) in 248 settlements. The table shows the settlements with an intensity of V to VI-VII. Its total amount is 38.

The largest number of responses was predictably received from the cities of the Southern Baikal region, including Irkutsk (563), Ulan-Ude (198), Gusinoozersk (79), Angarsk (69), Kyakhta (43)



INTENSITY VI-VII (BABUSHKIN TOWN)





INTENSITY VI (GUSINOOZERSK TOWN)

Δ=104 km, 79 responses an unexpectedly high and historically unprecedented value for this site

Eyewitnesses exhibited a strong reaction: fear, attempts to take cover, and in some cases, dizziness and loss of balance.

Key effects included

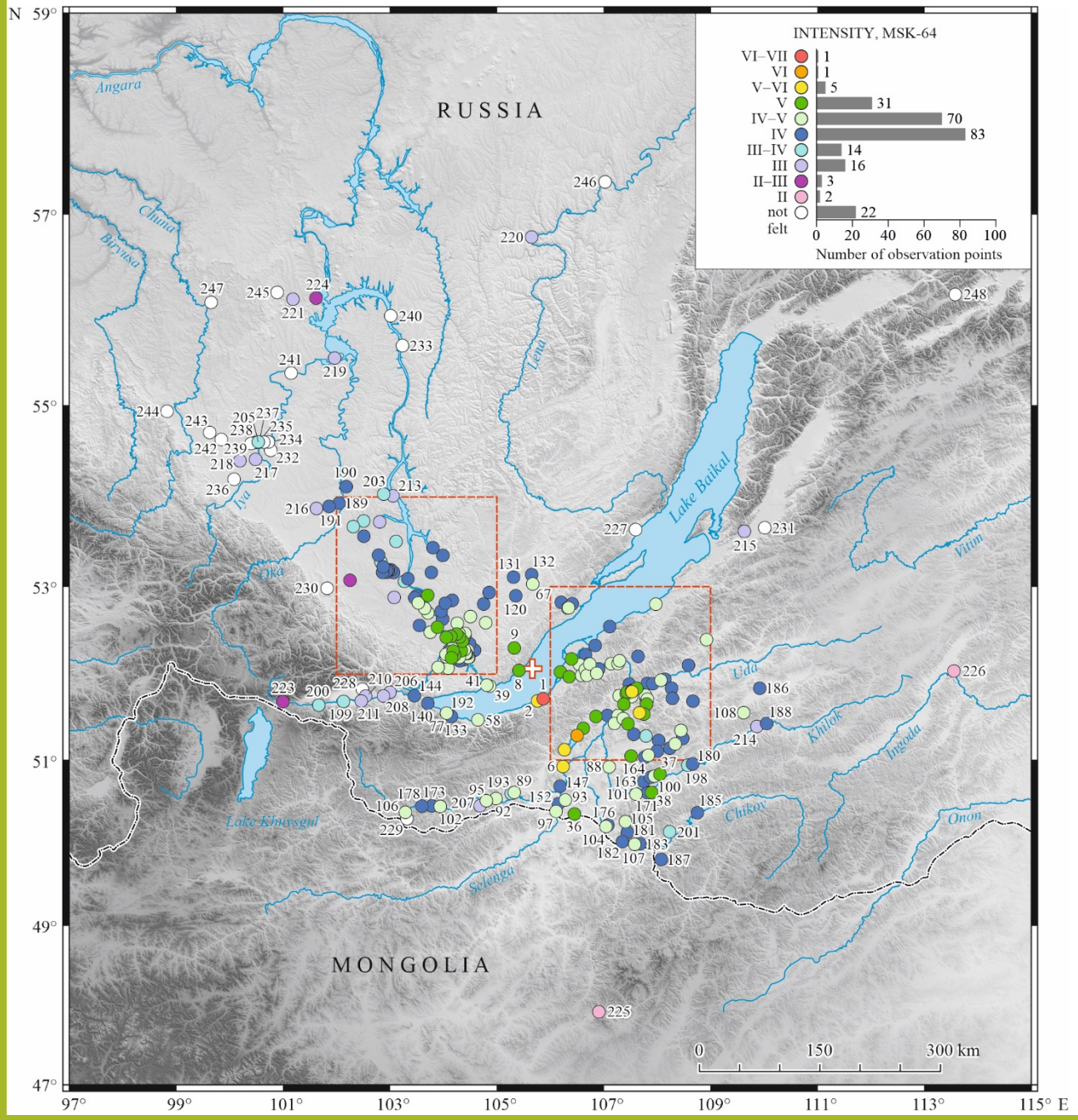
rattling dishes (65%),

noticeable furniture vibration (45%),

falling objects (18%),

spontaneous door movement, swinging chandeliers, and cracking plaster.

The earthquake was not felt in moving vehicles.



INTENSITY V-VI

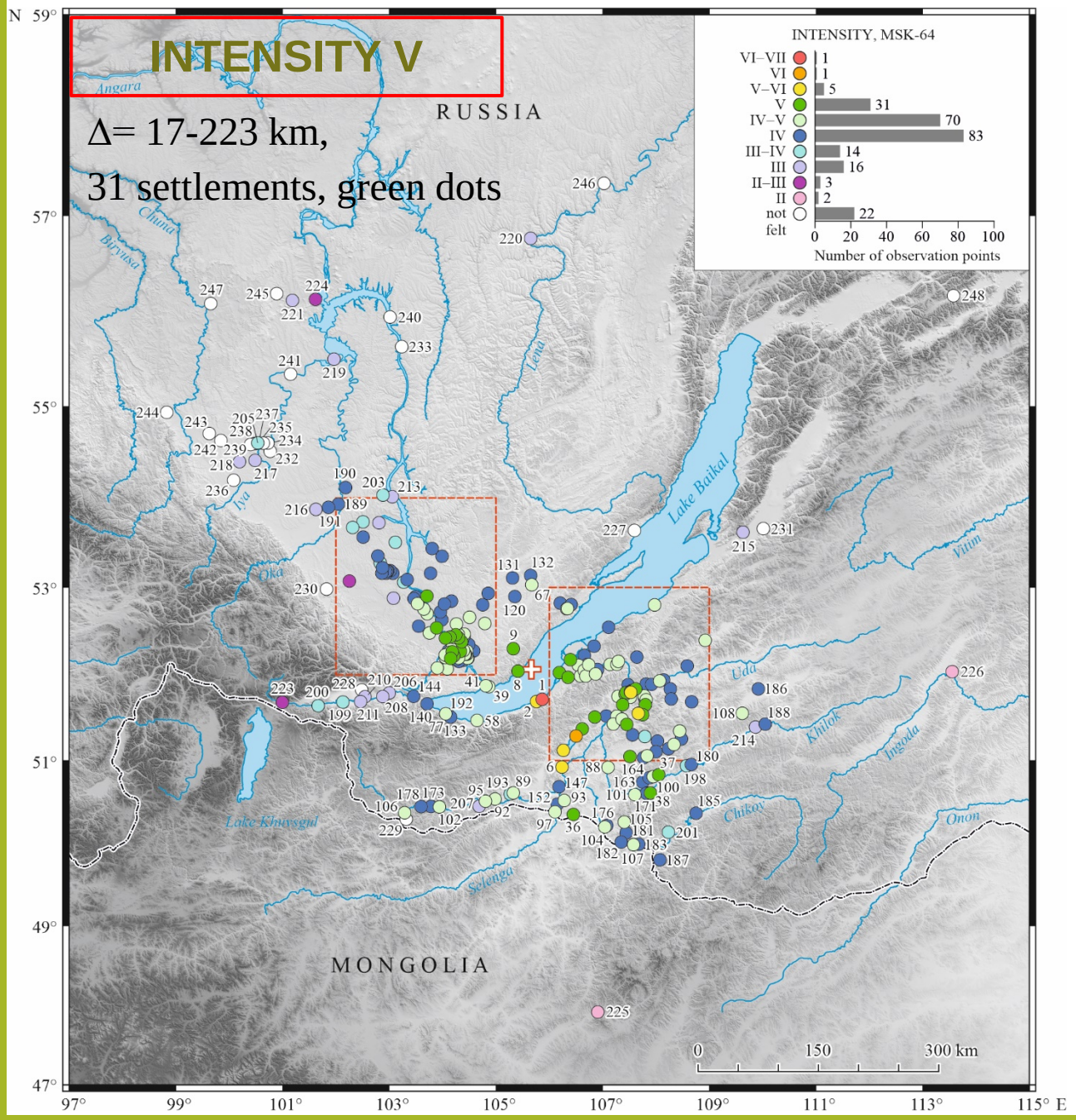
Δ= 42-149 km, 5 settlements, yellow dots

Locality	Coordinates		Δ, km	number of questionnaires	I, MSK-64
	LAT	LON			
Klyuyevka	51.688	105.758	42	3	V–VI
Gusinoye Ozero	51.114	106.261	113	1	V–VI
DNP Rubin	51.794	107.526	131	1	V–VI
Selenduma	50.917	106.236	133	1	V–VI
Nadeino	51.548	107.666	149	1	V–VI

The shaking caused great fear; some residents left buildings or took cover.

In Klyuyevka, effects included dish rattling, furniture shaking, falling objects, swinging doors, visible building swaying, and plaster cracking.

Comparable effects were reported in Gusinoye Ozero, Nadeino, Selenduma, and Rubin DNP



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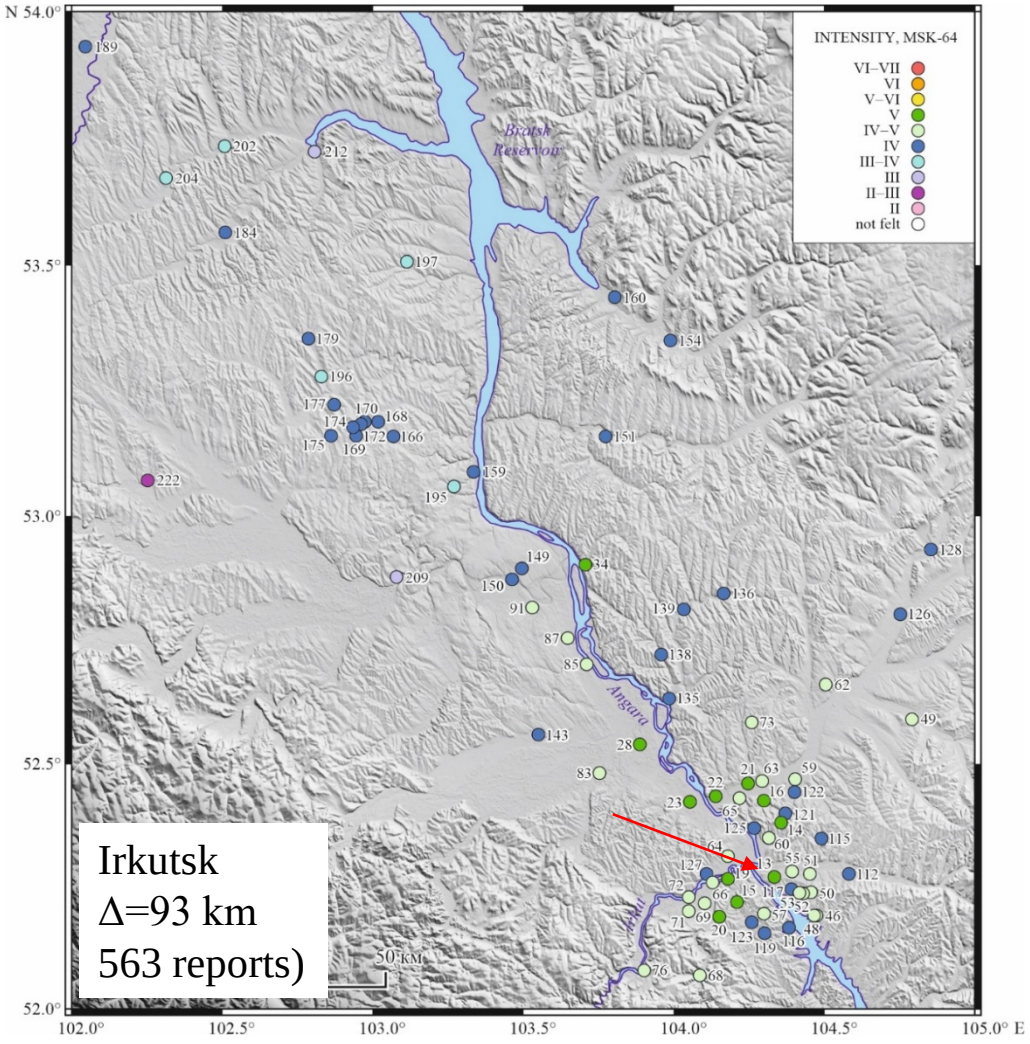
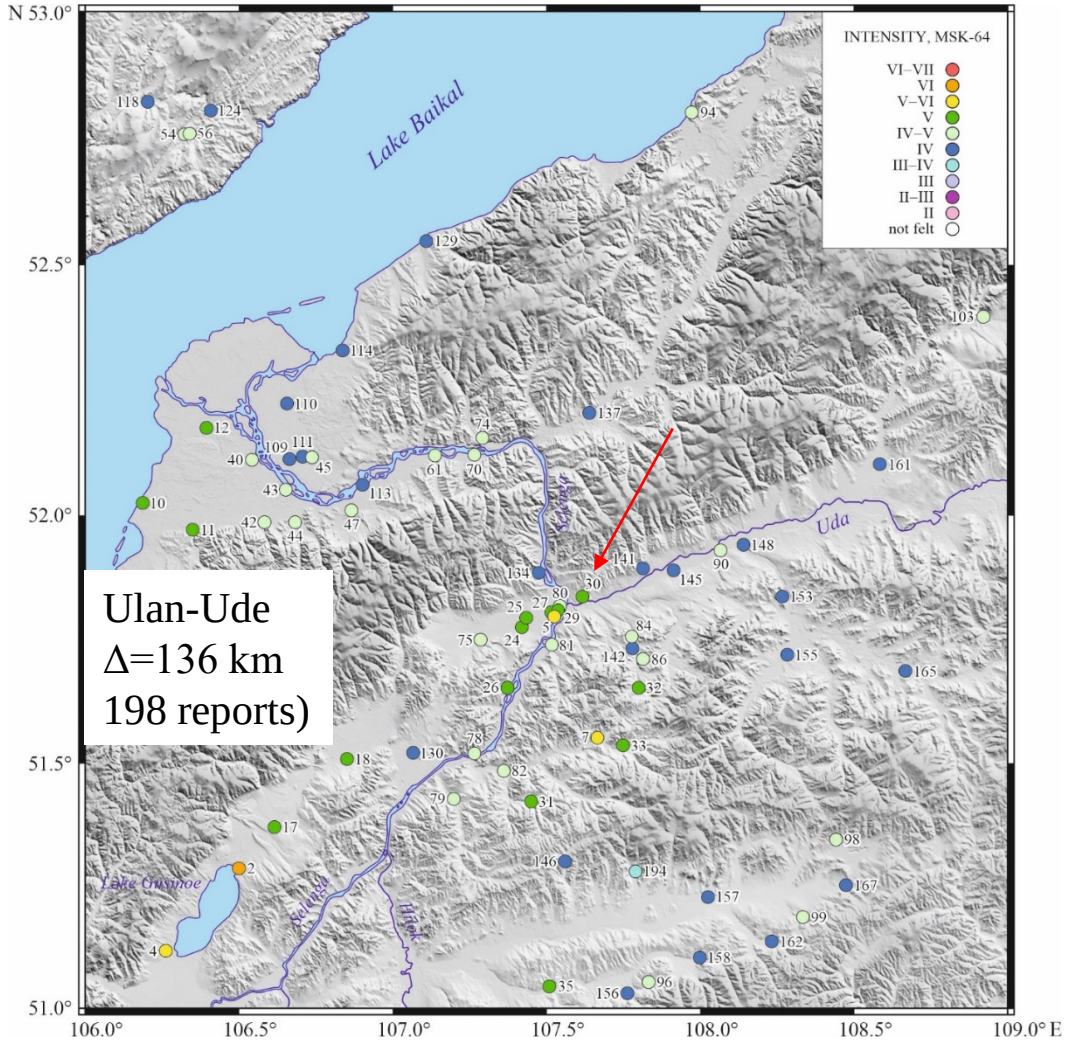
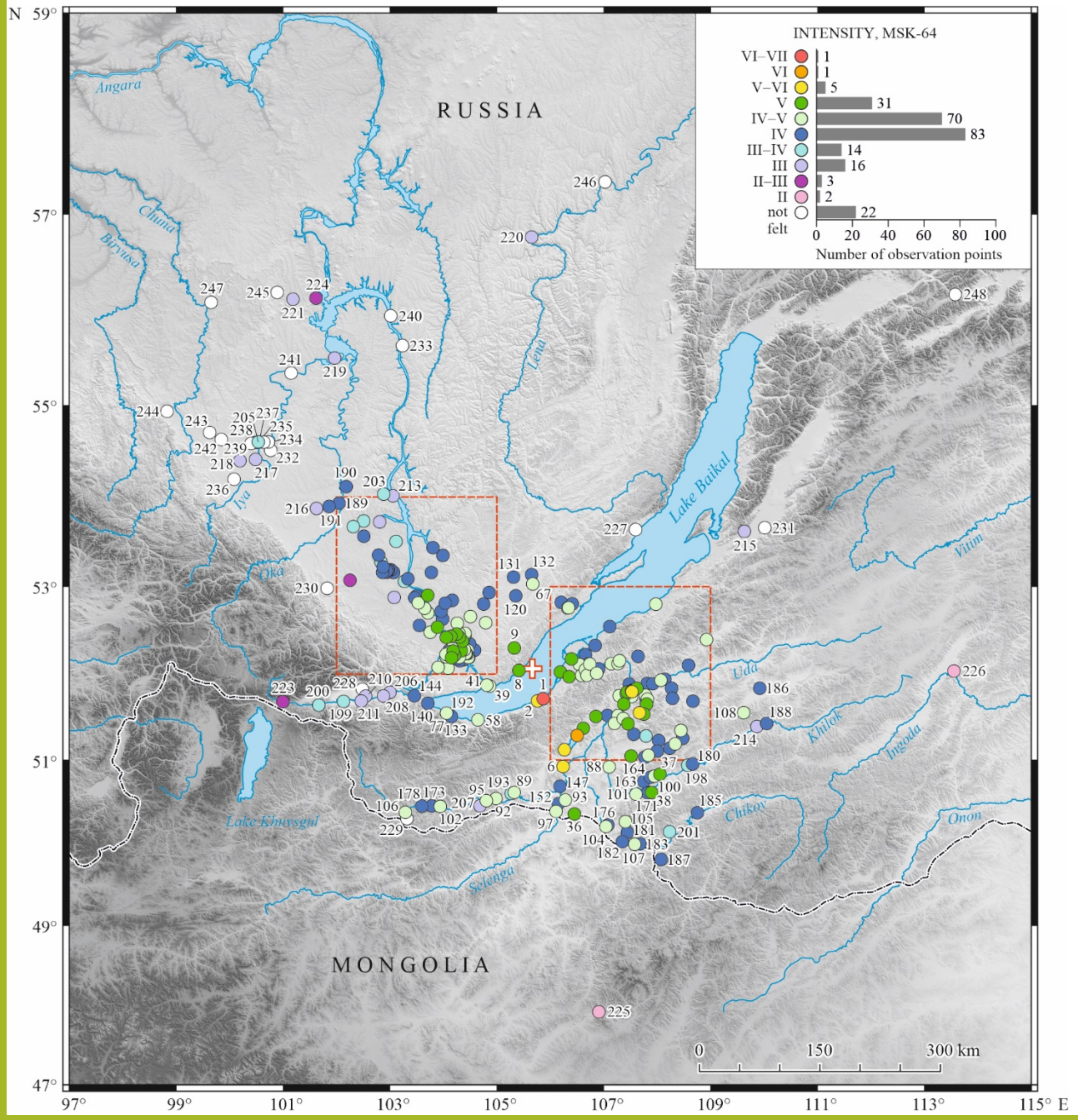
Macroseismic observations of the Goloustnaya-III earthquake

in the upper reaches of the Angara River and in the vicinity of Irkutsk



in the lower reaches of the Selenga River and in the vicinity of Ulan-Ude





INTENSITY IV-V and IV

The macroseismic field of the Goloustnaya-III event is mainly defined by IV and IV–V observations.

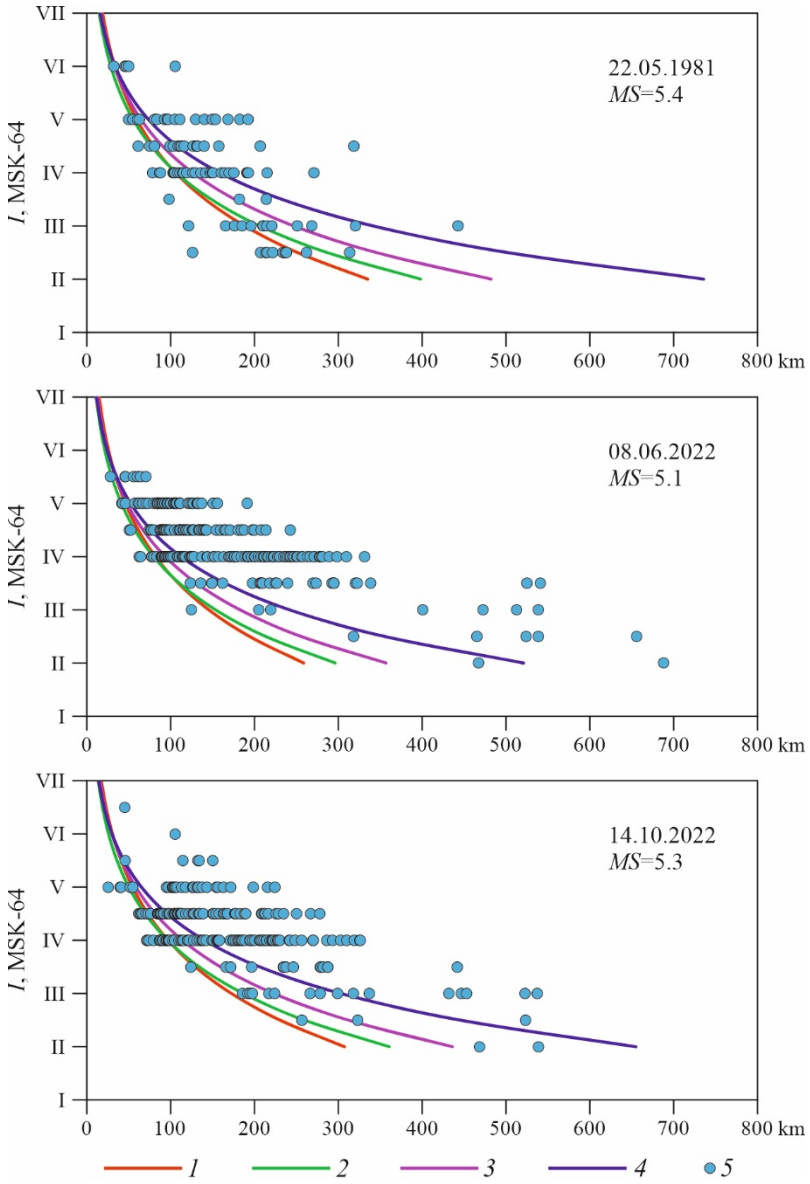
IV-V: Δ= 59-277 km,
70 settlements,
light green dots

IV: Δ= 69-325 km,
83 settlements,
blue dots

The minimum intensity (II) was felt in Ulaanbaatar (468 km) and Chita (538 km), where isolated resting individuals noticed slight vibrations.

In 22 settlements it was not felt at all.

Attenuation of shaking intensity depending on hypocentral distance for the three Goloustnaya earthquakes



The dataset for the earthquake of May 22, 1981, is given after [*Golenetsky et al., 1984*], and for the earthquake of June 8, 2022, after [*Radziminovich et al., 2023*].

Theoretical attenuation curves calculated using the macroseismic equation (1) with different sets of coefficients:

$$I = bM - vLg\sqrt{\Delta^2 + h^2} + c$$

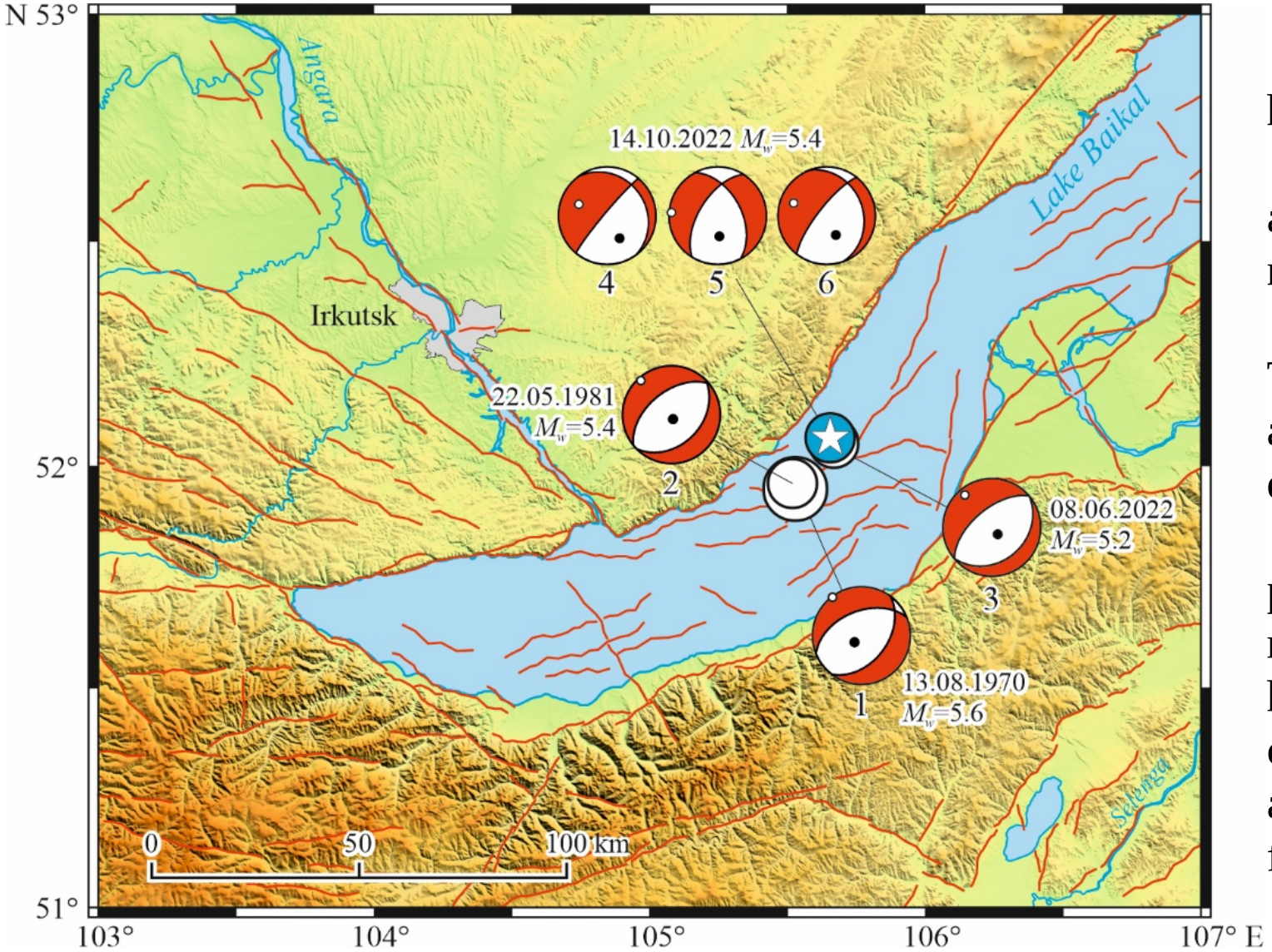
1 – red curve: b = 1.5, v = 4.0, c = 4.0 [Novy…, 1977],
2 – green curve: b = 1.5, v = 3.5, c = 3.0 [Shebalin, 1972],
3 – purple curve: b = 1.5, v = 3.44, c = 3.13 [Frolova et al., 2019],
4 – violet curve: b = 1.5, v = 3.0, c = 2.5 [Seismic…, 1977];
5 – dots: observed shaking intensity.

CONCLUSIONS

- **First**, the Goloustnaya-III earthquake ranks fourth among all Baikal earthquakes in terms of the number of macroseismic points (248), following the Kultuk 2008 (322), Bystraya 2020 (263), and Goloustnaya-II 2022 (255) events.
- **Second**, the macroseismic fields of all three Goloustnaya earthquakes are very similar. This confirms that earthquakes of magnitude 5.0–5.5 in the southern Baikal water area can produce intensity VI–VII and pose a real hazard to lakeside settlements.
- **Third**, the observed attenuation is much lower than predicted by the official regional equation. We need to revise the macroseismic equation currently used in the Baikal region. The Golenetsky equation with b = 1.5, v = 3.0, c = 2.5 deserves serious attention.
- **Fourth**, the online questionnaire system proved its efficiency, but it needs better infrastructure to handle peak loads. We also need to develop strategies to reach remote areas.
- Finally, our results are directly useful for seismic hazard assessment and risk evaluation in the southern Baikal region.

THANK YOU FOR YOUR ATTENTION

The work was supported by Ministry of Science and Higher Education of the Russian Federation, using data obtained with large-scale research facilities «Seismic infrasound array for monitoring Arctic cryolitozone and continuous seismic monitoring of the Russian Federation, neighbouring territories and the world» (https://ckp-rf.ru/usu/507436/, http://www.gsras.ru/unu/).



Such macroseismic field pattern has three possible explanations:

First, more settlements in those azimuths increase felt reports, while the northeast is sparsely populated.

Second, the Siberian Platform and Transbaikalia have high seismic quality and low attenuation, favoring long-distance effects.

Third, the SW–NE fault planes of preceding events indicate a link to regional tectonics. The 2022 event also has a NW–SE plane with a strike-slip component, which may have additionally shaped the macroseismic field.

Mechanisms of the Goloustnaya earthquake sources in the projection of the lower hemisphere. Active faults are marked in red according to the AFEAD database [Zelenin et al., 2022].

Macroseismic data was obtained as a result of:

direct survey of settlements in the near zone,

online filling out of questionnaires by the population
by calling village administrations and the unified duty dispatch service (EDDS).