

Kevin Mackey (mackeyke@msu.edu), Kenneth Abrams (abramak@msu.edu), Michigan State University, United States of America
 Anna Berezina (annaberezina8@gmail.com), Elena Pershina (evp_71@mail.ru), Institute of Seismology, National Academy of Science, Kyrgyz Republic
 Natalia Mikhailova (mikhailova@kndc.kz), Inna Sokolova (ISokolova@kndc.kz), Institute of Geophysical Research, Republic of Kazakhstan
 Bayan Bekturganova (bayan_0106@mail.ru), Seismological Experimental Methodological Expedition, Republic of Kazakhstan
 Shohrukh Murodkulov (shohrukh.m@mail.ru), Zuhra Ilyasova (Zuhra.ilyasova60@gmail.com), Institute of Geology, Earthquake Engineering, and Seismology, Republic of Tajikistan

T2.5-P2



Abstract:

Central Asia is located in a tectonically active and complex region. The area is characterized by high levels of seismicity, and many catastrophic earthquakes have occurred. Central Asia also contains or is within regional distances of many of the world's nuclear test sites. Seismic networks in the region were developed during Soviet times, with each republic operating independent networks with standardized processing and analysis. The current distribution of seismic networks generally remains the same, though networks are now national and operated by independent countries. From Soviet times until today, most bulletin and event data were not fully exchanged between Central Asian networks. The fact that only subsets of event data were routinely exchanged and used has hindered all aspects of seismological research in the region, such as investigation into regional Earth structure, calculation of event parameters, incomplete seismic risk assessment, etc. To improve all aspects of seismological research and knowledge in Central Asia, we are merging bulletin data from the networks of Kyrgyzstan, Tajikistan, and Kazakhstan into a single database. Following completion of the database, all events will be relocated, and the completed comprehensive bulletin will be submitted to the International Seismological Centre for inclusion into the global database.

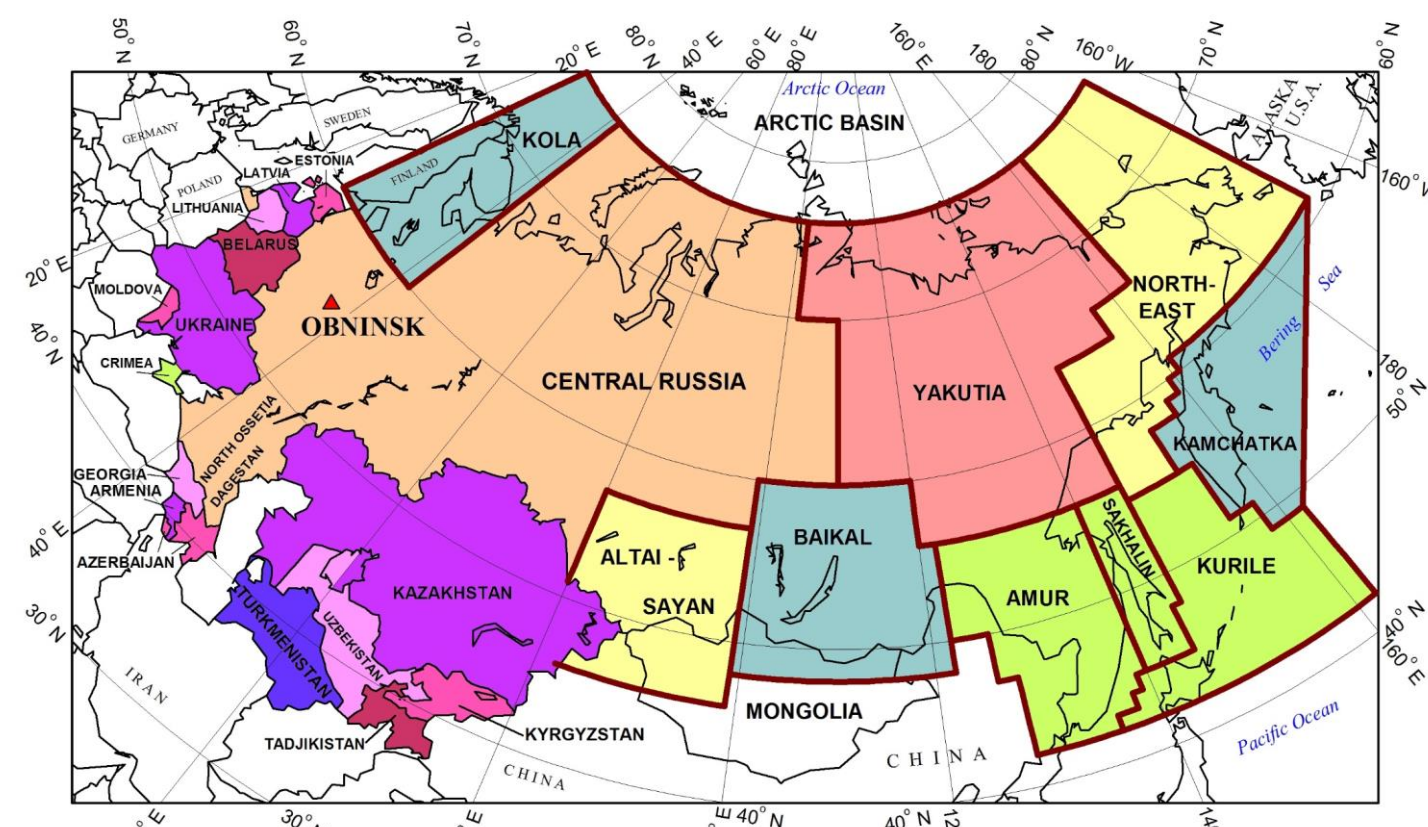


Figure 1: Seismological networks encompassing the Former Soviet Union. This project is assembling bulletins for Central Asia, at lower left on the map.

Location:

Central Asia (Figure 1) has a long history of seismic network operations from the 1950's through present. For most of this time period, operations were analog and bulletins do not exist in digital format. The archives in Central Asia (Figure 2) retain the hard copy analysis for decades of network recordings, likely containing several million phase-time picks and amplitudes.



Figure 2: Seismogram archive in Kyrgyzstan showing original bulletins in red binders at left, and paper seismograms at right. This archive is typical for the data we are compiling.

Data Sources:

In addition to original network data from Kazakhstan, Kyrgyzstan, and Tajikistan, several additional digital and hard copy sources containing historic catalogs and bulletins are incorporated (Figure 3). Although some data are duplicated across sources, each also contains some information that is unique,

International Sources	Regional Sources	Regional and Local Sources – Data specific to Central Asia
 International Seismological Centre ISC Catalogs and Bulletins (digital)	 ЗЕМЛЕТРЯСЕНИЯ В СССР Earthquakes of the USSR (Early 1960's -1993). Analog, but a digitized catalog exists.	 Earthquakes of Central Asia and Kazakhstan Materials on the Earthquakes of Siberia. Covers E. Kazakhstan.
 Seismological Bulletin - Obninsk (analog)	 ЗЕМЛЕТРЯСЕНИЯ СРЕДНЕЙ АЗИИ И КАЗАХСТАНА Earthquakes of Northern Eurasia (1994 – Present). Most have digital tables on accompanying CD's.	 СИЛЬНЫЕ ЗЕМЛЕТРЯСЕНИЯ СРЕДНЕЙ АЗИИ И КАЗАХСТАНА Strong Earthquakes of Central Asia and Kazakhstan
	 Bulletin of the Seismological Network of Tajikistan CASRI database (digital catalog and bulletin)	 Bulletin of the Seismological Network of Tajikistan EMCA database (digital catalog)
		 Bulletin of the Seismological Network of Tajikistan Dushanbe City Bulletin (digital catalog and bulletin)

Figure 3: Catalog and bulletin data publications for Central Asia divided into International, Regional, and Local sources. Some of the local sources are very difficult to find as some print runs were 50 or less

Procedures:

The first step in the process of the Central Asia Comprehensive Bulletin assembly is to merge existing digital archives together and associate events. The prepopulated file is then circulated through each network where catalog (events only) information is added. Once there is as complete as possible catalog, the file is again circulated and phases, arrival times, amplitudes, etc. are added to complete the bulletin. Most data are manually typed because the original bulletins usually cannot be accurately recovered with character recognition (Figure 4). The historic Central Asian data also contains several additional data fields, such as Energy Class (K), alternate magnitude calculations, 3-component amplitudes, etc. that are not typically found in global data, which we feel are important to retain.

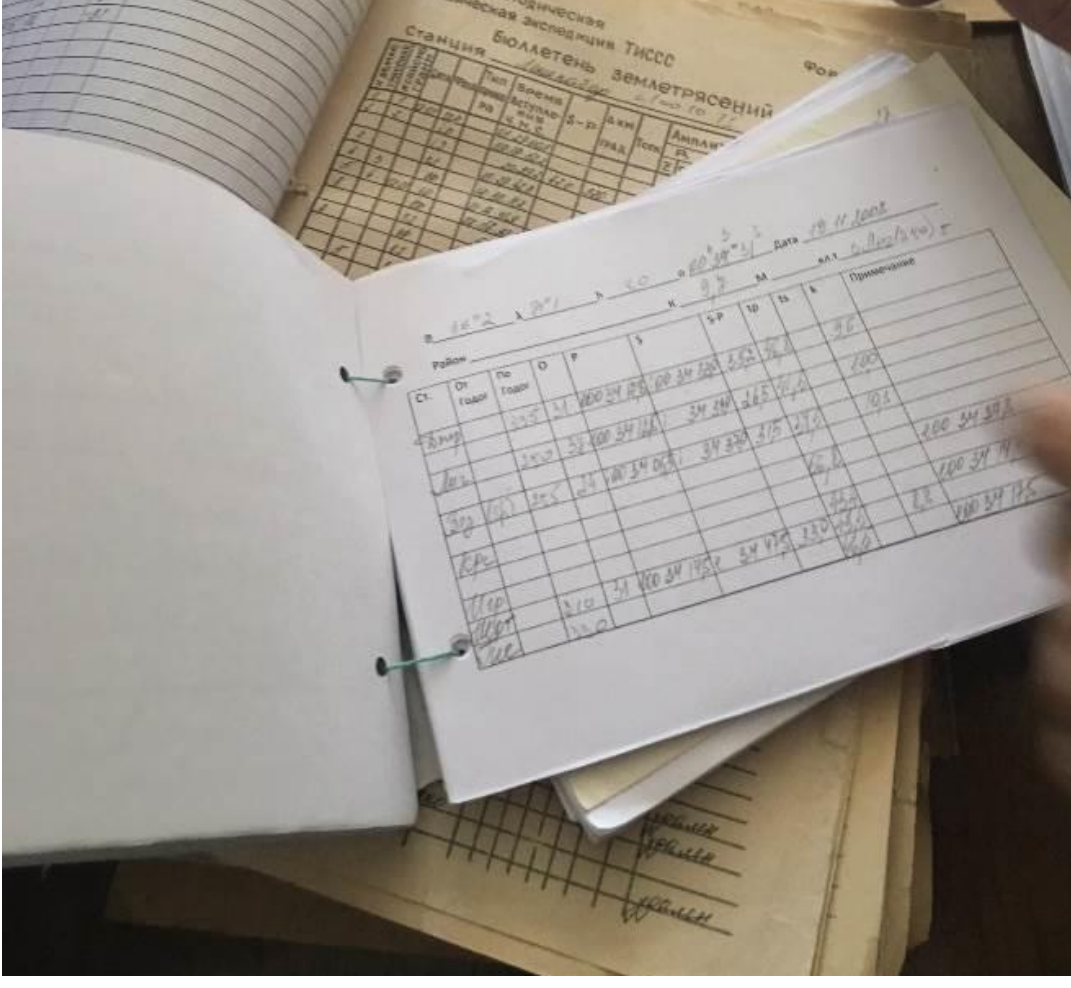


Figure 4: Original hand-written bulletin data from the Tajikistan network. This type of bulletin cannot accurately be recovered through scanning and character recognition, thus it is entered manually.

Software:

To facilitate the retention of all parameters and ease of use for manual data entry, we designed a custom software package called QuakeBase (Figure 5). QuakeBase stores data in a SQL relational database. The software is designed to operate on different Windows platforms without a complex installation procedure and not requiring libraries, is simple and intuitive to use, is tailored to data styles used in Central Asia networks and archives, and allows importation of existing digital bulletins such as EMCA, ISC, etc.

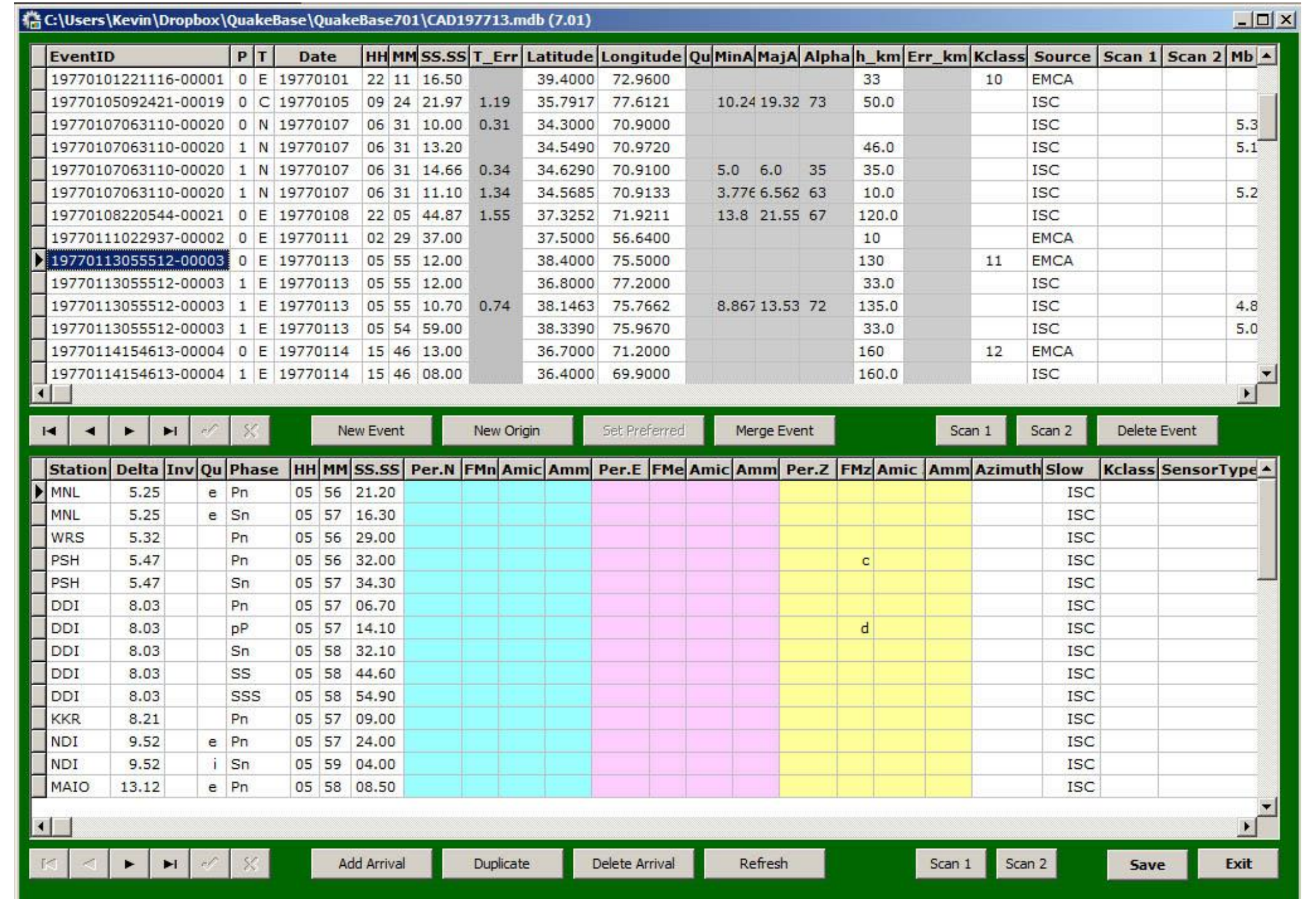


Figure 5: Screenshot of the QuakeBase data entry software. The upper panel contains all event parameters and the bottom panel shows phase, arrival, amplitude, etc. data for the event highlighted on top. Many additional data fields are entered but not visible in this screenshot

Seismic Stations:

The seismic station metadata is a critical component of a seismological database. For Central Asia, many seismic stations are poorly documented, do not have international station codes assigned, and/or use low precision coordinates. As a part of this project, when possible, we are compiling a 'passport' for each station that includes station history, previously undocumented station relocations, precision coordinates, and calibration information (Figure 6). As a part of this project, stations not currently in international registries will have codes assigned and we will work with the International Seismological Centre to make parameters available.

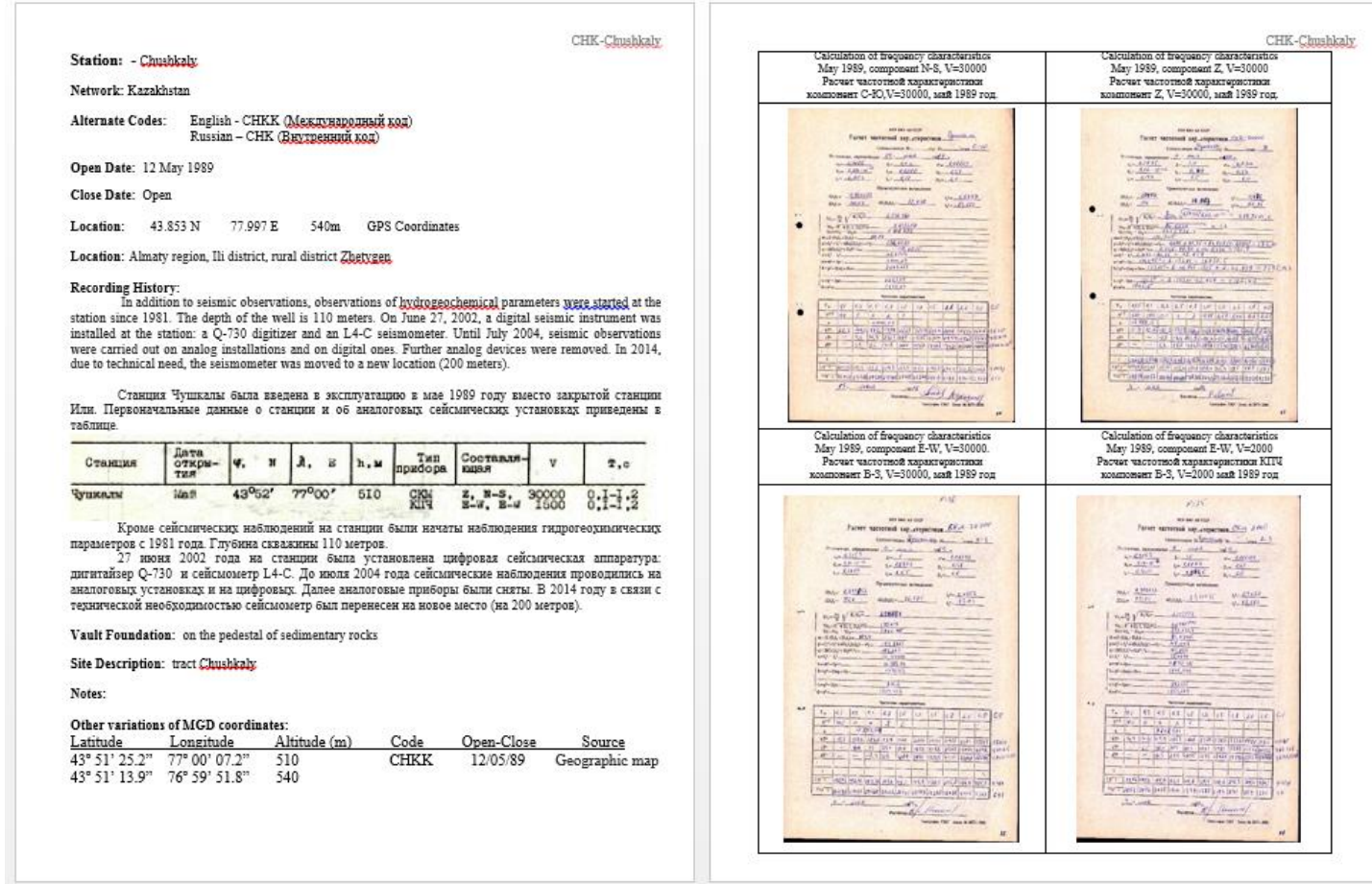


Figure 6: Fragment of the passport for the Kazakhstan station CHKK. At left are station parameters and history and at right are calibration data sheets.

Data Preservation and Error Correction:

Of utmost importance in the Comprehensive Central Asia Bulletin assembly is the preservation of the original data and the accuracy of data entered. We are scanning each original data document and linking it in the QuakeBase software. All future users then have access to the original data sheets and can review the database for accuracy and correct typographical errors.

Conclusions:

The ongoing Comprehensive Central Asia Bulletin assembly project will facilitate research in the region. Specifically, the resulting data, including events (see sample in Figure 7), phase parameters, and updated station tables, will be integrated into the International Seismological Centre Bulletin, which will facilitate access to seismologists and the global nuclear monitoring community. An ongoing companion project will utilize these data to calculate Probabilistic Seismic Hazard Assessments for each participating country. It is hoped that in the near future, colleagues from neighboring countries can contribute data for more comprehensive coverage of the region.

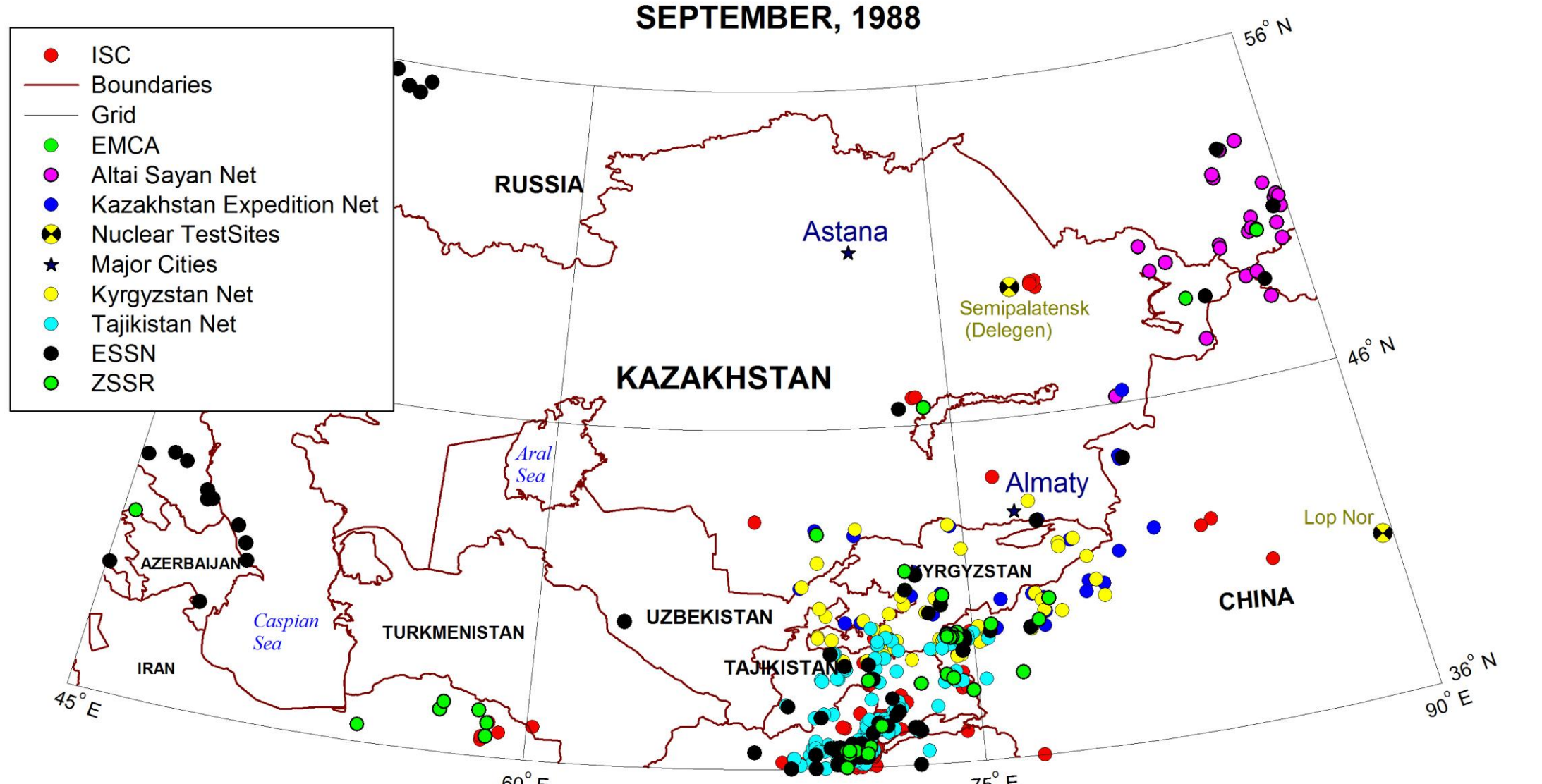


Figure 7: The map shows a representative sample of data from the Comprehensive Central Asia Bulletin. Events plotted are from September, 1988, and are derived from 8 sources. Over 1000 events are plotted, with most having occurred in Tajikistan.

The views expressed here do not necessarily reflect the views of the United States Government, the United States Department of energy, the National Nuclear Security Agency, or the Lawrence Livermore National Laboratory. This effort is funded by NNSA NA-24, the U.S. Department of Energy, National Nuclear Security Administration, Office of Nonproliferation and Arms control. LLNL-PRES-774253.