JOINT VERIFICATION EXPERIMENT 2
Information Product
Semipalatinsk Explosion on September 14, 1988
Technical Reference Manual

Version 1.0

November 5, 1993

Contributed by

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OUTLINE

1. Introduction

In August and September, 1988, the United States and the Soviet Union conducted a Joint Verification Experiment in which each country was permitted to monitor, using hydrodynamic methods, a nuclear explosion conducted at the other country's test site. In addition, as a part of the official experiment each country made teleseismic ($\Delta \geq 2500$ km) measurements at five stations in the U.S. and five stations in the USSR. Independently, the Natural Resources Defense Council (NRDC) struck an agreement with the Academy of Sciences of the USSR to record the Soviet JVE explosion at regional distances ($\Delta < 2500$ km) inside the USSR (USA-USSR Agreement, 1988; Gordon, 1988; Robinson, 1989).

On September 14, 1988 the Soviet Union conducted an underground nuclear explosion in Eastern Kazakhstan, near the southern edge of the Shagan River subregion of the USSR's main nuclear weapons test site near Semipalatinsk. In this information product, we present seismic records of this explosion which were obtained both regionally and teleseismically inside the USSR. In addition to records directly related to this experiment, included in this information product are seismograms observed at the Soviet Geophysical Observatory at Borovoye, Kazakhstan, at U.S. Global Seismological Network stations and at French GEOSCOPE stations outside of the U.S.S.R. The position of the exlosion site and the station layout for epicentral distances less than 3500 km are shown in figure 1. For detailed descriptions of the JVE experiment and results of data interpretation performed by several research groups, see the references at the end of this report.

2. Acknowledgements

Many individuals contributed on a number of levels to the Joint Verification Experiment. The following is a list of names and institutions that identify some of the major contributors to the Joint Verification Experiment 2 and to the observation and distribution of the data contained in this information product.

Name	Institution
Charles Archambeau	University of Colorado
Rick Aster	University of California at San Diego

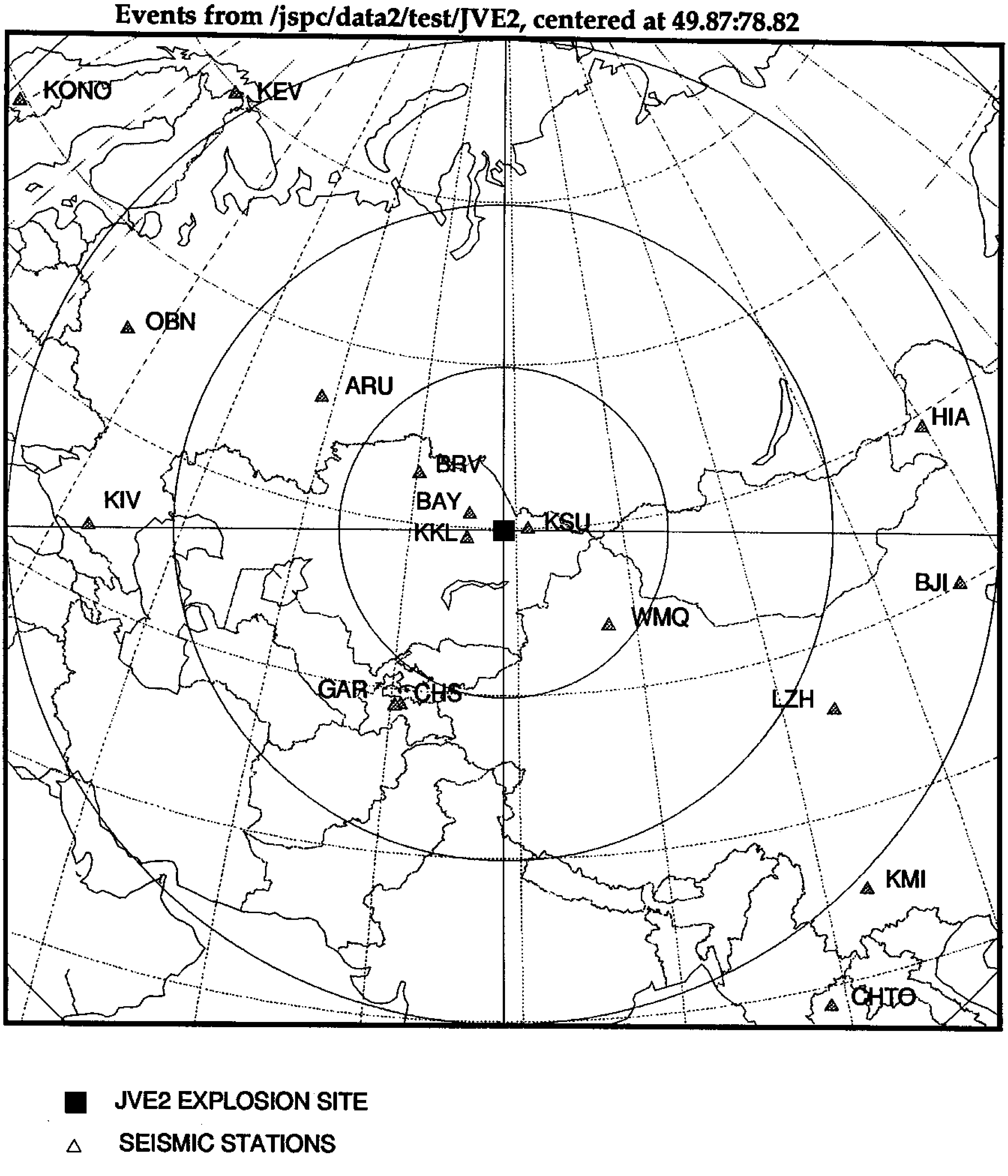

Figure 1. JVE2 test location and surrounding stations.

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3. Explosion, Site, Instrumentation, and Data Review

The JVE2 explosion was conducted on September 14, 1988, at 03:59:59.69 Greenwich time, in Northern Kazakhstan, at the Shagan River Test Site (49.869 N, 78.825 E) at a depth of about 600m below the surface (Lilwall & Farthing, 1990). The body wave magnitude of the explosion has been estimated at Mb = 6.03 (Ringdal & Marshall, 1989), the seismic moment has been estimated to be approximately $M_0 = 1.3 \times 10^{23}$ dyne-cm, and the yield was approximately 130 ± 10 kton (Xie, 1993).

In this subsection we briefly describe the waveform data included in this product and problems that must be addressed in their interpretation.

3.1. Data from regional stations.

During the JVE experiment three regional stations were operated by teams from the University of Nevada at Reno (UNR) and the University of Wisconsin (UW) (Meyer, 1989; Priestley et al., 1990). These stations were installed at the sites previously occupied by a group from UCSD/IGPP during the NRDC experiments (Berger, et al,1987; Eissler et al, 1988). These sites are Bayan-Aul (BAY, Δ= 255 km), Karkaralinsk (KKL, Δ= 255 km) and Karasu (KSU, Δ=160 km).

3.1.1. The UW deployment.

KKL and KKLA Karkaralinsk, Kazakhstan

BAY and BAYA	Bayan-Aul, Kazakhstan
KSU and KSUA	Karasu, Kazakhstan

The University of Wisconsin deployed six three-component digitally recording seismographs with nominal 1 Hz Hall-Sears HS 10-1 seismometers. All of the sites were located in regions of extensive granitic and granodioritic outcrops, which in some neighboring areas displayed extensive exfoliation. Stations KKL, BAY, KSU were installed on piers of the previously deployed UCSD/IGPP installations. Stations KKLA, BAYA were on the surface within 100 m of the pier site, and station KSUA was within 250 m of the pier site, situated on an outcrop elevated about 40m higher than the pier. The instruments at all stations except KSUA were equipped with a 24db attenuator in the seismometer input bridge circuit. KSUA has a 12 db attenuator. The sampling rate was 200 sps, with a four pole Butterworth anti-aliasing filter with the 3 db point at 50 Hz.

The following convention for channel names is used:

HSSE	high gain, surface, short period, east
HSSN	high gain, surface, short period, north
HSSZ	high gain, surface, short period, vertical

3.1.2. The UNR deployment.

KKL	Karkaralinsk, Kazakhstan
BAY	Bayan-Aul , Kazakhstan
KSU	Karasu, Kazakhstan

The University of Nevada at Reno deployed three short-period and three long-period instruments at KKL, BAY and KSU on the same pier sites as UW. The short-period instruments consisted of three component Teledyne-Geotech S-13 seismometers with a 1 second free period seismometers and EDA PRS-4 digital data loggers. The long-period seismographs consisted of three component Teledyne Geotech SL210/220 seismometers with a 15 second free period seismometers and a Kinemetric PDR-2 digital data logger. All the data were sampled at 200 Hz, with the exception of the short period seismograph at BAY which was sampled at 100 Hz. Only two horizontal long-period records for KSU are presented here. No instrumental responses for these stations are available to incorporate in the information product at the moment. To distinguish the UNR data from the UW data obtained at the same sites the names LPZ, LPN and LPE were used for the UNR long-period channels and the names SPZ, SPN and SPE for short-period channels. (The 'P' stands for "Priestley").

Problems with these Data:

(1) Data recorded at BAY appear to be about 1.25 s late on the short-period channels and 2.7 s late on the long-period channels.
(2) Data from KKL are about 2 s late on both short- and long-period channels.
(3) Data from KSU are approximately 30 s earlier on long-period channels.

3.1.3. Borovoye Geophysical Observatory.

BRV	Borovoye, Kazakhstan

The Borovoye Geophysical Observatory (BRV) is situated in North-Eastern Kazakhstan (Adushkin & An, 1990; Richards et al., 1992). At the time of the JVE experiment, BRV was affiliated with the Institute of Physics of the Earth, Acad. Sci. of the USSR. Data from BRV were submitted by W.-Y. Kim and P.G. Richards (Lamont-Doherty Earth Observatory of Columbia University). The epicentral distance from the JVE explosion is 691 km. Data presented in this information product were obtained using several types of seismographs. Short-period seismometers are of the SKM-3 type with a free period of 2 sec, KSM and KS types with a free period 1.5 sec (Parameters..., 1989; Shishkevish, 1975). Intermediate-period seismometers are of the DS type, with a free period of 20 sec. Data loggers are of TSG and SS types, with a sampling rate of 38 or

42 samples per second for the short period channels and approximately 3 samples per second for the intermediate period channels. The response parameters describing these seismic systems are unknown to us, but the related amplitude-frequency responses (Parameters..., 1989) are relatively flat for ground displacements in their pass-band (about a decade). Hence it should be possible to work with these data taking into account only the corresponding values of CALIB and CALPER in the CSS v. 3.0 data base schema.

The following name conventions are used:

ipe	intermediate period , DS-seismometer, east
ipn	intermediate period, DS-seismometer, north
ipz	intermediate period , DS-seismometer, vertical
spe	short-period, KS-seismometer, east
spn	short-period, KS-seismometer, north
spz	short-period, KSM-seismometer, vertical
SPE	short-period, SKM-seismometer, east
SPN	short-period, SKM-seismometer, north
SPZ	short-period, SKM-seismometer, vertical

Problems with these Data:
(1) Short-period horizontal channels are clipped in such a way that only the first arrivals are useful.

3.2. Data from teleseismic stations.

3.2.1. The IRIS/IDA network in the USSR.

ARU	Arti, Russia
CHS	Chusal, Tadjikistan,
GAR	Garm, Tadjikistan,
KIV	Kislovodsk, Russia
OBN	Obninsk, Russia

The stations of the IRIS/IDA network in the USSR used for the JVE experiment were OBN (Obninsk, near Moscow, Δ= 2882km), CHS(Chusal, near Afgan border, Tadjikistan, Δ= 1356km), KIV(Kislovodsk, Caucasus region, Δ= 2802 km), ARU(Arti, southwestern Urals region, Δ= 1528km), GAR (Garm, Tajikistan), approximately 35 km away from CHS (Δ= 1382 km).

There were high-frequency and broad-band systems at each site. The high-frequency sensors are Teledyne Geotech 54100 three component borehole seismometers deployed at 100 meters depth, with a flat response in velocity between 0.2 Hz - 80 Hz, and Teledyne Geotech GS13 surface seismometers with a flat velocity response between 1 Hz - 80 Hz. Ground motions are digitized at 250 samples per second and recording is event-detected for the high-frequency system. This system is the same that was used in Kazakhstan from February - September 1987, in the NRDC project. The borehole seismometer at ARU has a flat response in acceleration. Borehole sensors at the other sites have a shaping circuit that makes the response flat to velocity.

For the broadband system, sensors are either Streckheisen STS-I or Guralp CMG3, where the velocity output was continuously recorded and digitizied at 20 samples per second. The high-frequency and broadband instruments were co-located at all sites except CHS, where the broadband sensors were located at the IRIS/IDA station GAR.

The following conventions for channel names are used:

HSSE	high gain, surface, short period, east

HSSN	high gain, surface, short period, north
HSSZ	high gain, surface, short period, vertical
LSSE	low gain, surface, short period, east
LSSN	low gain, surface, short period, north
LSSZ	low gain, surface, short period, vertical
HSIE	high gain, surface, intermediate period, east
HSIN	high gain, surface, intermediate period, north
HSIZ	high gain, surface, intermediate period, vertical
LSIE	low gain, surface, intermediate period, east
LSIN	low gain, surface, intermediate period, north
LSIZ	low gain, surface, intermediate period, vertical
HBIE	high gain, borehole, intermediate period, east
HBIN	high gain, borehole, intermediate period, north
HBIZ	high gain, borehole, intermediate period, vertical
LBIE	low gain, borehole, intermediate period, east
LBIN	low gain, borehole, intermediate period, north
LBIZ	low gain, borehole, intermediate period, vertical
HBAE	high gain, borehole, accelerometer, east
HBAN	high gain, borehole, accelerometer, north
HBAZ	high gain, borehole, accelerometer, vertical
LBAE	low gain, borehole, accelerometer, east
LBAN	low gain, borehole, accelerometer, north
LBAZ	low gain, borehole, accelerometer, vertical

Standard names are used for broad-band surface channels.

Problems with these Data:

(1) Data from the BL-channels at KIV were exactly 20 s late due to a clock error. Corrected.

(2) Data from the BL-channels at OBN are approximately 1 s early due to a clock error. Uncorrected.

(3) Data from all channels at ARU were exactly 10 s late due to a clock error. Corrected.

(4) Data from the B -channels at GAR are approximately 2 sec early due to a clock error. Uncorrected.

3.2.2. The GSN - CDSN - IRIS/IDA network outside the USSR.

AFI	Afiamalu, Western Samoa
ANMO	Albuquerque, New Mexico, USA
ANTO	Ankara, Turkey
BJI	Baijatuan, Beijing, China
CHTO	Chiang Mai, Thailand
CHS	Chusal, Tadjikistan,
CMB	Columbia College, California, USA
COL	College Outpost, Alaska, USA
CTAO	Charters Towers, Australia
ESK	Eskadalemuir, Scotland, UK
GAC	Glen Almond, Quebec, Canada
GUMO	Guam, Marianas Islands
HIA	Hailar, Neimenggu Province, China
HON	Honolulu, Hawaii, USA
HRV	Harvard, Massachusetts, USA

KEV	Kevo, Finland
KIP	Kipapa, Hawaii, USA
KMI	Kunming, Yunnan Province, China
KONO	Kongsberg, Norway
LEM	Lembang, Indonesia
LON	Longmire, Washington, USA
LZH	Lanzhou, Gansu Province, China
MAJO	Matsushiro, Japan
NWAO	Narrogin, Australia
RPN	Rapanui, Easter Island, Chile
SCP	State College, Pennsylvania, USA
SLR	Silverton, South Africa
TAU	Hobart, Tasmania, Australia
TOL	Toledo, Spain
WMQ	Urumqi, Xinjiang Province, China
ZOBO	Zongo Valley, Bolivia

The JVE explosion was recorded by many stations in the GSN, CDSN and IRIS/IDA networks. In 1989 the DMC distributed the corresponding set of data on an exabyte tape for both American and Soviet JVE explosions. These data for the JVE2 retrieved from the DMC are included here to make the set of data for this event as complete as possible and to present data in the CSS v. 3.0 format with verified instrument responses. This data subset contains records of 30 stations obtained with different types of instruments: long- (LH), short- (SH), intermediate- (MH) period and broad-band (BH). Instrument responses and other information about stations can be easily retrieved from the corresponding data base.

Standard channel names are used.

3.2.3. The GEOSCOPE network.

INU	Inuyama, Japan
SSB	St. Sauveur, France

The JVE explosion was recorded by some stations of the GEOSCOPE network equipped with long-period instruments. Records of stations SSB and INU are retrieved from the GEOSCOPE CDROM, Global Seismological Data, v. 2 and are included in this product.

Standard channel names are used.

4. Summary of Problems with the Data

There are a number of timing and instrument response problems with the data included in this product. The known timing errors are:

GAR data for BL-channels are approximately 2 s early.
OBN data for BL-channels appear to be 1 s early.
BAY data for SP-channels appear to be 1.25 s late.
BAY data for LP-channels appear to be 2.7 s late.
KKL data for both SP- and LP- channels appear to be 2 s late.
KSU data for LP-channels appear to be 30 s early.

The instrument response problems are:

KKL, KSU, BAY (UNR deployment) - no responses or CALIB values are available at this moment for all LP- and SP- channels .

BRV - no responses for all channels.

In addition, a number of recordings are clipped, including the following:

BRV - spe, spn, SPN, SPE channels.

5. The Data Base and Installation

The data base included in this product follows the CSS v. 3.0 relational data base schema (Anderson et al., 1990). A desription of this schema is given in *JVE2 Information Product Schema Reference Manual*. Related software and installation procedures are described in the *Software* and *Installation/Tutorial Manuals*. In addition to waveform data, there are eleven relations containing parametric and response information included in this product. Each relation is named such that the root name prefix identifies the product, JVE2, and the suffix identifies the relation itself. For example, the wfdisc relation is named JVE2.wfdisc. The following relations are included: affiliation, arrival, event, origin, instrument, lastid, network, sensor, site, sitechan, and wfdisc.

The JVE2.event and origin files contain 1 row corresponding to the JVE2 event. The JVE2.wfdisc file contains 344 rows equal to the number of waveform files presented in the product. Data from 13 networks are presented, so the JVE2.network file contains 13 rows. A total of 44 stations and 281 channels are contained in the product so the JVE2.affiliation and JVE.site possess 44 rows and the JVE2.sitechan file contains 281 rows. The JVE2.arrival file contains 41 P-waves travel time estimates. Instrument information is presented in the JVE2.sensor and JVE2.instrument files; 187 different instrument descriptions are included. The instrument response files themselves

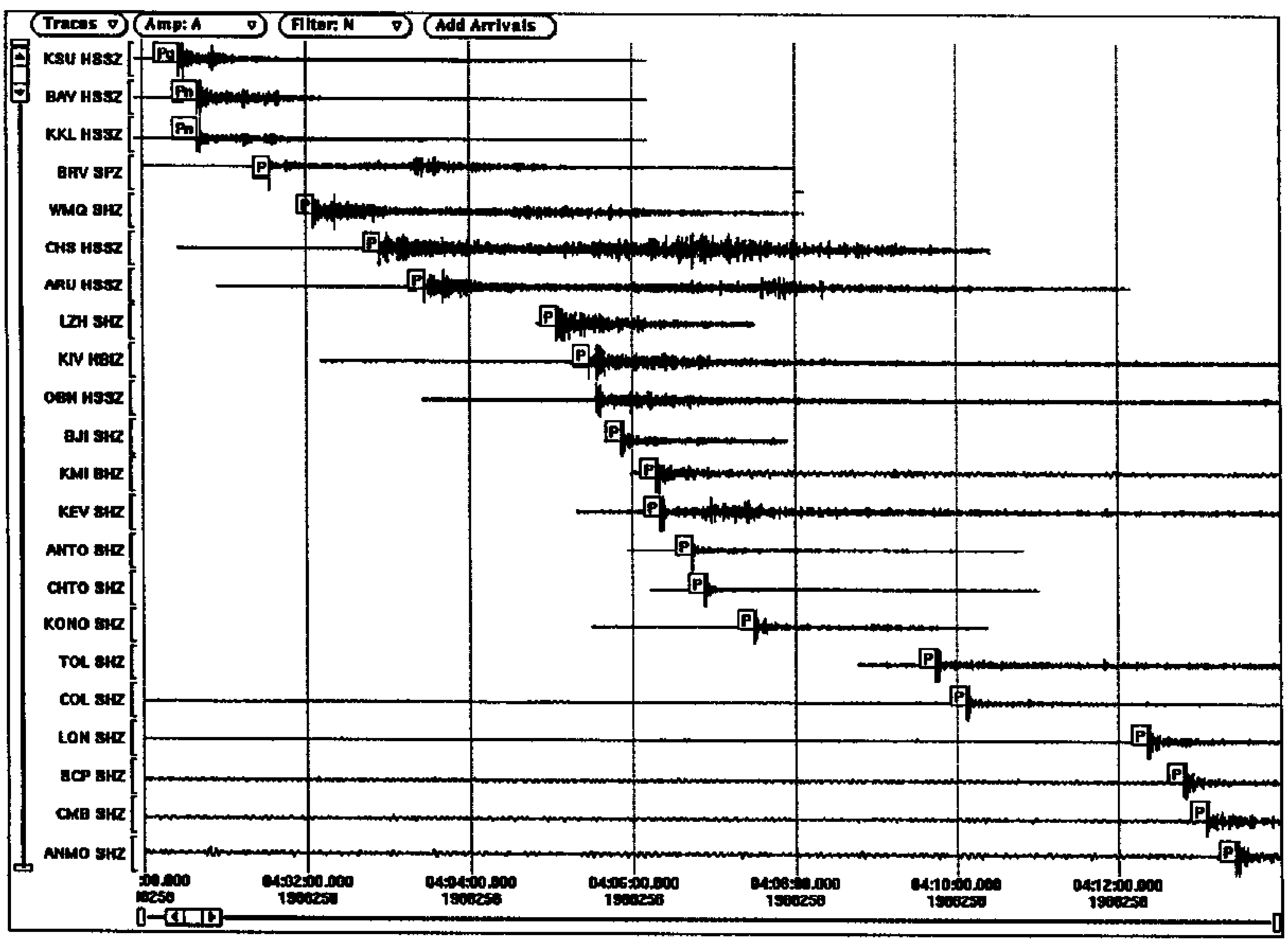

Figure 2. Representative waveforms following the JVE2 test.

are located in the response subdirectory. Waveform data are located in the subdirectory called 'sac' to which the wfdisc files point. Each of the waveform files in this directory are in the SAC format, however event information is not included in the SAC headers in each file. An example of a record section for high-frequency vertical channels including first arrivals of P waves at epicentral distances from 160 to 10,600 km is shown in Figure 2.

6. References

The following is a list of references related to this information product. We have tried to make this list realtively comprehensive, including both the references mentioned in this report and other references describing research that has been done with these data. We have concentrated on listing published reports. However, there are manuscripts which have not been included in this list that may be published in the future. Please let us know of any published materials that are missing from this list. We apologize in advance for unintentional omissions.

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