

Digital Seismogram Data from
Borovoye Geophysical Observatory
Northern Kazakhstan

submitted by

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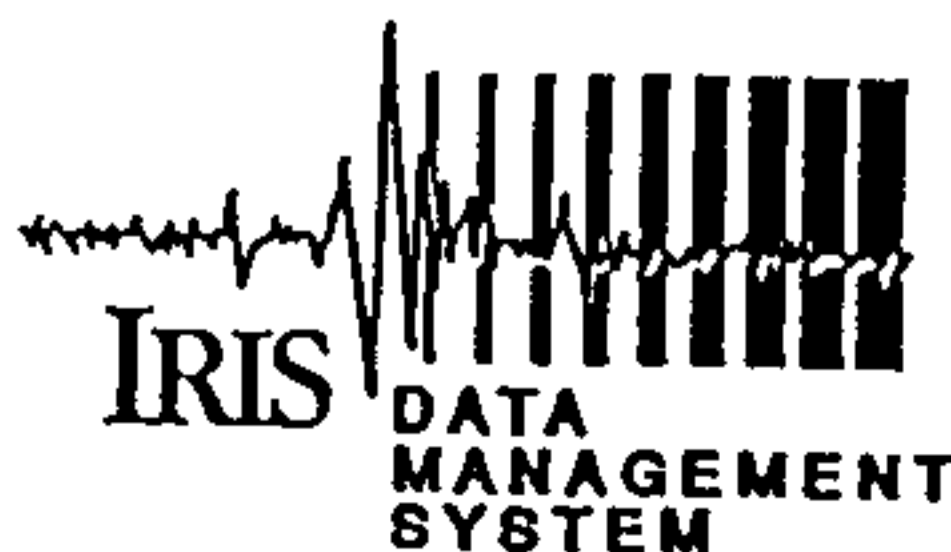
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Introduction

This note describes certain digital seismograms recorded by Borovoye Geophysical Observatory (BRV), in northern Kazakhstan. We received a magnetic tape containing 43 files of digital seismogram data in March 1991 from Dr. Vitaly Adushkin of the Institute for Dynamics of Geosphere, Moscow. This digital seismogram data, resulting from the data request made by Paul Richards in December 1990, were processed by the authors at the Lamont-Doherty Geological Observatory (LDGO) and are submitted here for interested scientists. These 43 files contained digital seismograms from 25 earthquakes and underground explosions recorded at BRV during the past 20 years. The list of 25 events are given in Table 1.

This note describes information regarding these waveform data and provides basic parameters needed to analyze them. Further details of the BRV station can be found in a report by Richards and Ekstrom (1991) and a recent article by Richards, Kim and Ekstrom (1992) to appear in EOS.

BRV Seismogram Data in ADM Format

The magnetic tape we received was written by PDP/11 type computer at BRV with tape density of 800 bpi. The 43 data files contained in the tape are in a processing format called ADM. That is, ADM format data are processed on computer from the original archive tape at BRV, that were recorded in 17 track, wide tape (35 mm). Note that the original archive tapes were recorded by LMR-3 (June 1966 - Nov. 1973) and LMR-6 (Feb 1973 - present) digital recorders (Adushkin & An, 1990), and these data loggers wrote up to 24 channels of digital data.

Each of the 43 files contains 3-component digital seismograms, yielding a total of 129 waveform traces. Each file consists of series of data blocks (block size=512 bytes) which contains 256 samples (16 bit, two-byte unsigned integer per sample) of single component seismogram, either Z, NS or EW component. These data blocks are multiplexed block-wise (i.e., Z, N, E, Z, N, E, ...).

Data values are encoded in the lowest 11 bits (bits 0-11; bit 0 being the least significant bit). Therefore, data values range from 0 to 2048 unsigned integers. Four bits (bits 12 through 15) of the two-byte samples are not used, except the first 64 bytes of the first blocks, where the *time stamp* is encoded in bits 12 through 15. The time stamp provides information on channel number, digitizing interval, date, record start time (to nearest msec) and time correction.

Note that there are several drop offs of data points which were represented as "null" value in the original data. These drop offs were known to be due to the "time stamping" process in the original recording stage at BRV (Shishkevish, 1975). There are also "null" data values toward the end of the trace, and these are believed to be due to filling "null" values to fill the requested time window when data were played

back from the original 17-track tape in order to write the ADM format files.

It should be noted for these 43 examples that the data in ADM format is of variable quality. Some signals are badly clipped. However, for some examples the data is of excellent quality. We understand that in generating the ADM format tape from the archive at Borovoye there is a problem, since only three channels from the wide archive tape (up to 24 channels) can be written to ADM at each data processing. But it is not obvious which 3 channels should be chosen from the 24, since it is not easy to view all 24 channels as an aide in making the best selection. We are therefore pursuing methods to make a direct copy from the archive tape to a standard half inch tape, that will transfer all 24 channels.

Submitted Waveform Traces in AH Format

The digital seismogram data in ADM format have been demultiplexed and decoded for the time stamps and data values. Data are demeaned for the dc offset and each single waveform trace is then put into an AH (*ad hoc*) format file used at LDGO for waveform analysis. Further information on AH format is given in a later section.

Table 2 lists all 129 waveform traces retrieved from the tape in AH format. The columns in Table 2 gives information on date (refer to the event date given in Table 1), channel number, seismic system, gain of each channel and file names of the waveform traces.

The seismic system represented as a character string indicates the system used (KOD, SS for STsR-SS and TSG for STsR-TSG), and seismometer used (SKM, SKD, KS, DS etc.; see also Table 3), as well as the component of ground motion which is indicated by a letter Z, N and E, for vertical, north-south and east-west components, respectively. For example, the first entry in Table 2, KOD-SKM-Z indicates that the record is from KOD system with SKM seismometer and is vertical component.

Trace file names in AH format are in the form of,

BRV.yearmodd.hhmm.system.channel.ah

where *year* =year, *mo* =month, *dd* =day, *hh* =hour and *mm* =minute are the record start time and are close to the event origin time given in Table 1. *system* indicates the seismograph system used followed by seismometer type. *channel* =channel number, which is useful to identify its nominal instrument characteristics given in Table 3. The last characters in the file name *ah* indicates that the data is in AH format.

All of the AH format files that we submit have their headers filled with relevant information except poles and zeroes of the instrument responses. These parameters are not yet well enough determined to put into AH headers. Note that most of the seismographs used at BRV have relatively flat response to the *ground displacement* in their

pass-bands (usually about a decade). We feel that the gain for each channel provided should suffice for a wide variety of data analyses and interpretations. For further details regarding the seismographs and the station, we refer to the report by Richards & Ekstrom (1991).

Gain of Seismogram Trace and Instrument Responses

Gains of each channel listed in Table 2 are for the **digital counts/micron in ground displacement**. This table is based on the information provided by the staffs at BRV (Karim Khaidarov & Aborin) via V. Adushkin during June 1991 and subsequently verified by Paul Richards while he visited BRV during August 1991. There are two events which were not in Khaidarov's list. In this case, we took the nominal gain for these channels at the time of recording. These traces are noted at the bottom of Table 2. The gains for the traces from event of 1980 SEP 14 on SS-SKD channels were listed as from 2600 to 3220, but we believe that these were probably wrong. A nominal gain of about 5 would be expected for these channels.

Table 3 summarizes the instrument characteristics at BRV known to us so far. This table has been compiled using information from 1) Adushkin and An (1990), 2) Paul Richards' & G. Ekstrom's hand written note of the copies of the *logbook* kept at Borovoye, 3) Karim Khaidarov's notes faxed to us during 1991, and 4) W.-Y. Kim's calculation of instrument responses based on several calibration pulses in digital form brought by Paul Richards and Goran Ekstrom during August 1991. A complete description on the response of the instruments used at BRV listed in Table 3 will be available in the future.

AH Format Waveform Files

The AH file consists of a fixed block of header information (1024 bytes), and floating point data values in binary. The AH header contains information on the

Station : station code, component, station type, latitude, longitude, elevation, digital sensitivity (gain), normalization constant and poles and zeroes of the instrument response used.

Event : latitude, longitude, focal depth, origin time and comment (region etc).

Record : sampling interval (dt), maximum amplitude in the waveform, record beginning time (in absolute time, GMT), number of samples in the trace.

It is relatively simple to convert these AH format files into other formats using widely available computer codes. For example, there are conversion codes for SAC,

SEGY, CSS.v3, CSS.v2.7, ASCII and many other data formats used in the seismological community. The users who are not familiar with AH formats or need assistance in converting AH format files into other formats may contact Won-Young Kim via e-mail

wykim@lamont.lidgo.columbia.edu

or directly *ftp* the necessary public domain software available from Lamont-Doherty through Internet using simple ftp commands, as

```
> ftp
ftp> open 129.236.10.30
login: anonymous
password: anonymous
ftp> cd pub
ftp> get ah.ms ah.ms
ftp> get ah.tar.Z ah.tar.Z
ftp> quit
```

The file *ah.ms* is a text file containing a manual for the AH format in "troff" setting and *ah.tar.Z* contains unix "tar" compressed files containing various AH filters and AH i/o routines useful to use AH format files.

References

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Table 1. List of Events for Digital Seismograms from BRV

	year doy	Origin time		Lat (N)	Long (E)	h (km)	mb	Ms	Reference
		mon dd	hh:mm:sec						
01	1969-121	MAY 01	04:00:08.7	43.98	77.86	25.4	4.9	-	EQ,3,7,9
02	1969-265	SEP 22	16:14:58.9	41.35	88.33	0	5.2	-	CH,3
03	1972-345	DEC 10	04:27:10.00	50.027	78.896	0.5	5.96	-	SR,4,6,10
04	1973-204	JUL 23	01:23:00.11	49.966	78.810	0	6.17	-	SR,4
05	1976-080	MAR 20	04:03:39.3	50.02	77.37	0	5.1	-	EQ,2,8
06	1977-253	SEP 10	02:59:58.0	73.339	54.626	0	5.71	-	NZ,5
07	1977-282	OCT 09	10:59:58.0	73.414	54.935	0	4.51	-	NZ,5
08	1978-241	AUG 29	02:37:08.75	50.011	78.976	0	5.90	-	SR,4,6,10
09	1980-258	SEP 14	02:42:41.63	49.930	78.801	0	6.21	-	SR,4
10	1983-279	OCT 06	09:59:58.0	41.53	88.72	0	5.5	4.2	CH,3
11	1984-276	OCT 03	05:59:57.9	41.54	88.67	0	5.4	-	CH,3
12	1984-354	DEC 19	06:00:02.8	41.62	88.22	33	4.7	4.2	CH,3
13	1987-156	JUN 05	04:59:58.5	41.55	88.72	0	6.2	4.7	CH,3
14	1988-044	FEB 13	03:05:08.17	49.932	78.878	0	5.97	-	SR,4
15	1988-094	APR 03	01:33:08.12	49.909	78.918	0	5.99	-	SR,4
16	1988-125	MAY 04	00:57:09.08	49.931	78.741	0	6.09	-	SR,4
17	1988-128	MAY 07	22:49:58.12	73.364	54.445	0	5.6	3.8	NZ,2
18	1988-166	JUN 14	02:27:08.98	50.034	78.964	0	4.80	-	SR,4
19	1988-258	SEP 14	03:59:59.69	49.869	78.825	0	6.03	-	SR,4
20	1988-317	NOV 12	03:30:06.26	50.048	78.960	0	5.20	-	SR,4
21	1988-339	DEC 04	05:19:53.00	73.387	54.998	0	5.9	4.6	NZ,2
22	1988-352	DEC 17	04:18:09.17	49.879	78.924	0	5.80	-	SR,4
23	1989-128	MAY 08	00:03:14.4	44.90	79.73	33	4.5	4.1	EQ,3
24	1990-228	AUG 16	04:59:57.69	41.564	88.770	0.5	6.2	-	CH,2
25	1990-297	OCT 24	14:57:58.0	73.364	54.827	0	5.6	4.0	NZ,2

(1) Symbols used in Reference column are SR=Shagan River, EQ=Earthquake, NZ=Novaya Zemlya, CH=Chinese explosion.

(2) Preliminary Determination of Epicenters, Monthly listing, NEIC.

(3) Bulletin of the International Seismological Center.

(4) Locations are from Lilwall & Farthing (1990), and magnitudes are from Ringdal & Marshall (1989).

(5) Lilwall & Marshall (1986).

(6) Double explosions (these events are preceded by earlier explosions at Degelen Mt. area by about 10 sec).

(7) Landers (1972).

(8) Pooley et al. (1983).

(9) Pearce (1977).

(10) Clark & Pearce (1988).

Table 2. List of Digital Seismograms and Gains from BRV(a)

Date year mon day	Channel number	Seismic system	Gain(b) (unit/micron)	Seismogram trace id
1969 MAY 01	1	KOD-SKM-Z	-3512(c)	BRV.19690501.0402.KOD-SKM.01.ah
1969 MAY 01	3	KOD-SKM-N	-3277(c)	BRV.19690501.0402.KOD-SKM.03.ah
1969 MAY 01	4	KOD-SKM-E	-3468(c)	BRV.19690501.0402.KOD-SKM.04.ah
1969 SEP 22	1	KOD-SKM-Z	-3346(c)	BRV.19690922.1618.KOD-SKM.01.ah
1969 SEP 22	3	KOD-SKM-N	-3024(c)	BRV.19690922.1618.KOD-SKM.03.ah
1969 SEP 22	4	KOD-SKM-E	-3294(c)	BRV.19690922.1618.KOD-SKM.04.ah
1972 DEC 10	1	KOD-SKM-Z	-3308(c)	BRV.19721210.0428.KOD-SKM.01.ah
1972 DEC 10	3	KOD-SKM-N	-3434(c)	BRV.19721210.0428.KOD-SKM.03.ah
1972 DEC 10	4	KOD-SKM-E	-3422(c)	BRV.19721210.0428.KOD-SKM.04.ah
1973 JUL 23	1	KOD-SKM-Z	-3150(c)	BRV.19730723.0124.KOD-SKM.01.ah
1973 JUL 23	3	KOD-SKM-N	-2944(c)	BRV.19730723.0124.KOD-SKM.03.ah
1973 JUL 23	4	KOD-SKM-E	-3344(c)	BRV.19730723.0124.KOD-SKM.04.ah
1976 MAR 20	7	SS-SKM-Z	1187	BRV.19760320.0405.SS-SKM.07.ah
1976 MAR 20	8	SS-SKM-N	1388	BRV.19760320.0405.SS-SKM.08.ah
1976 MAR 20	9	SS-SKM-E	1266	BRV.19760320.0405.SS-SKM.09.ah
1976 MAR 20	7	SS-SKM-Z	1187	BRV.19760320.0411.SS-SKM.07.ah
1976 MAR 20	8	SS-SKM-N	1388	BRV.19760320.0411.SS-SKM.08.ah
1976 MAR 20	9	SS-SKM-E	1266	BRV.19760320.0411.SS-SKM.09.ah
1977 SEP 10	19	TSG-DS-Z	54.6	BRV.19770901.0304.TSG-DS.19.ah
1977 SEP 10	20	TSG-DS-N	52.3	BRV.19770901.0304.TSG-DS.20.ah
1977 SEP 10	21	TSG-DS-E	50.5	BRV.19770901.0304.TSG-DS.21.ah
1977 OCT 09	7	TSG-KS-Z	2190	BRV.19771009.1104.TSG-KS.07.ah
1977 OCT 09	8	TSG-KS-N	2270	BRV.19771009.1104.TSG-KS.08.ah
1977 OCT 09	9	TSG-KS-E	2110	BRV.19771009.1104.TSG-KS.09.ah
1978 AUG 29	1	SS-SKM-Z	172	BRV.19780829.0238.SS-SKM.01.ah
1978 AUG 29	8	SS-SKM-N	1346	BRV.19780829.0238.SS-SKM.08.ah
1978 AUG 29	9	SS-SKM-E	1358	BRV.19780829.0238.SS-SKM.09.ah
1980 SEP 14	1	SS-SKM-Z	172	BRV.19800914.0244.SS-SKM.01.ah
1980 SEP 14	8	SS-SKM-N	1227	BRV.19800914.0244.SS-SKM.08.ah
1980 SEP 14	9	SS-SKM-E	1270	BRV.19800914.0244.SS-SKM.09.ah
1980 SEP 14	2	SS-SKD-Z	2620(d)	BRV.19800914.0244.SS-SKD.02.ah
1980 SEP 14	3	SS-SKD-N	3220(d)	BRV.19800914.0244.SS-SKD.03.ah
1980 SEP 14	4	SS-SKD-E	3220(d)	BRV.19800914.0244.SS-SKD.04.ah
1983 OCT 06	7	SS-SKM-Z	2125	BRV.19831006.1003.SS-SKM.07.ah
1983 OCT 06	8	SS-SKM-N	2105	BRV.19831006.1003.SS-SKM.08.ah
1983 OCT 06	9	SS-SKM-E	2042	BRV.19831006.1003.SS-SKM.09.ah
1983 OCT 06	19	TSG-DS-Z	47.9	BRV.19831006.1003.TSG-DS.19.ah
1983 OCT 06	20	TSG-DS-N	47.6	BRV.19831006.1003.TSG-DS.20.ah

1983 OCT 06	21	TSG-DS-E	47.3	BRV.19831006.1003.TSG-DS.21.ah
1984 OCT 03	7	SS-SKM-Z	2041	BRV.19841003.0603.SS-SKM.07.ah
1984 OCT 03	8	SS-SKM-N	2071	BRV.19841003.0603.SS-SKM.08.ah
1984 OCT 03	9	SS-SKM-E	2077	BRV.19841003.0603.SS-SKM.09.ah
1984 DEC 19	7	SS-SKM-Z	2041	BRV.19841219.0603.SS-SKM.07.ah
1984 DEC 19	8	SS-SKM-N	2071	BRV.19841219.0603.SS-SKM.08.ah
1984 DEC 19	9	SS-SKM-E	2077	BRV.19841219.0603.SS-SKM.09.ah
1987 JUN 05	1	TSG-KSM-Z	48.9	BRV.19870605.0503.TSG-KSM.01.ah
1987 JUN 05	8	TSG-SBU-V(e)	1081	BRV.19870605.0503.TSG-KSM.08.ah
1987 JUN 05	12	TSG-KSM-E	103150	BRV.19870605.0503.TSG-KSM.12.ah
1987 JUN 05	19	TSG-DS-Z	50.0(f)	BRV.19870605.0503.TSG-DS.19.ah
1987 JUN 05	20	TSG-DS-N	50.0(f)	BRV.19870605.0503.TSG-DS.20.ah
1987 JUN 05	21	TSG-DS-E	50.0(f)	BRV.19870605.0503.TSG-DS.21.ah
1988 FEB 13	1	TSG-KSM-Z	48.6	BRV.19880213.0306.TSG-KSM.01.ah
1988 FEB 13	8	TSG-KS-N	4449	BRV.19880213.0306.TSG-KS.08.ah
1988 FEB 13	9	TSG-KS-E	4539	BRV.19880213.0306.TSG-KS.09.ah
1988 APR 03	1	TSG-KSM-Z	48.6	BRV.19880403.0134.TSG-KSM.01.ah
1988 APR 03	8	TSG-KS-N	4449	BRV.19880403.0134.TSG-KS.08.ah
1988 APR 03	9	TSG-KS-E	4539	BRV.19880403.0134.TSG-KS.09.ah
1988 APR 03	6	SS-SKM-Z	22.0	BRV.19880403.0134.SS-SKM.06.ah
1988 APR 03	8	SS-SKM-N	2047	BRV.19880403.0134.SS-SKM.08.ah
1988 APR 03	9	SS-SKM-E	1999	BRV.19880403.0134.SS-SKM.09.ah
1988 APR 03	19	TSG-DS-Z	50.17	BRV.19880403.0134.TSG-DS.19.ah
1988 APR 03	20	TSG-DS-N	48.5	BRV.19880403.0134.TSG-DS.20.ah
1988 APR 03	21	TSG-DS-E	47.9	BRV.19880403.0134.TSG-DS.21.ah
1988 MAY 04	1	TSG-KSM-Z	48.6	BRV.19880504.0058.TSG-KSM.01.ah
1988 MAY 04	8	TSG-KS-N	4449	BRV.19880504.0058.TSG-KS.08.ah
1988 MAY 04	9	TSG-KS-E	4539	BRV.19880504.0058.TSG-KS.09.ah
1988 MAY 07	1	TSG-KSM-Z	48.6	BRV.19880507.2254.TSG-KSM.01.ah
1988 MAY 07	8	TSG-KS-N	4449	BRV.19880507.2254.TSG-KS.08.ah
1988 MAY 07	9	TSG-KS-E	4539	BRV.19880507.2254.TSG-KS.09.ah
1988 MAY 07	7	SS-SKM-Z	2032	BRV.19880507.2254.SS-SKM.07.ah
1988 MAY 07	8	SS-SKM-N	2047	BRV.19880507.2254.SS-SKM.08.ah
1988 MAY 07	9	SS-SKM-E	1999	BRV.19880507.2254.SS-SKM.09.ah
1988 MAY 07	19	TSG-DS-Z	50.17	BRV.19880507.2254.TSG-DS.19.ah
1988 MAY 07	20	TSG-DS-N	48.5	BRV.19880507.2254.TSG-DS.20.ah
1988 MAY 07	21	TSG-DS-E	47.90	BRV.19880507.2254.TSG-DS.21.ah
1988 JUN 14	1	TSG-KSM-Z	48.6	BRV.19880614.0228.TSG-KSM.01.ah
1988 JUN 14	8	TSG-KS-N	4449	BRV.19880614.0228.TSG-KS.08.ah
1988 JUN 14	9	TSG-KS-E	4539	BRV.19880614.0228.TSG-KS.09.ah
1988 SEP 14	1	TSG-KSM-Z	48.6	BRV.19880914.0400.TSG-KSM.01.ah
1988 SEP 14	8	TSG-KS-N	4511	BRV.19880914.0400.TSG-KS.08.ah
1988 SEP 14	9	TSG-KS-E	4533	BRV.19880914.0400.TSG-KS.09.ah
1988 SEP 14	6	SS-SKM-Z	22.0	BRV.19880914.0401.SS-SKM.06.ah

1988 SEP 14	8	SS-SKM-N	2047	BRV.19880914.0401.SS-SKM.08.ah
1988 SEP 14	9	SS-SKM-E	1999	BRV.19880914.0401.SS-SKM.09.ah
1988 SEP 14	19	TSG-DS-Z	48.49	BRV.19880914.0400.TSG-DS.19.ah
1988 SEP 14	20	TSG-DS-N	48.19	BRV.19880914.0400.TSG-DS.20.ah
1988 SEP 14	21	TSG-DS-E	48.05	BRV.19880914.0400.TSG-DS.21.ah
1988 NOV 12	7	SS-SKM-Z	2032	BRV.19881112.0331.SS-SKM.07.ah
1988 NOV 12	8	SS-SKM-N	2047	BRV.19881112.0331.SS-SKM.08.ah
1988 NOV 12	9	SS-SKM-E	1999	BRV.19881112.0331.SS-SKM.09.ah
1988 NOV 12	19	TSG-DS-Z	48.49	BRV.19881112.0331.TSG-DS.19.ah
1988 NOV 12	20	TSG-DS-N	48.19	BRV.19881112.0331.TSG-DS.20.ah
1988 NOV 12	21	TSG-DS-E	48.05	BRV.19881112.0331.TSG-DS.21.ah
1988 DEC 04	1	TSG-KSM-Z	48.60	BRV.19881204.0524.TSG-KSM.01.ah
1988 DEC 04	8	TSG-KS-N	4511	BRV.19881204.0524.TSG-KS.08.ah
1988 DEC 04	9	TSG-KS-E	4533	BRV.19881204.0524.TSG-KS.09.ah
1988 DEC 04	3	TSG-KSM-Z	1009	BRV.19881204.0524.TSG-KSM.03.ah
1988 DEC 04	4	TSG-KSM-N	1028	BRV.19881204.0524.TSG-KSM.04.ah
1988 DEC 04	5	TSG-KSM-E	1030	BRV.19881204.0524.TSG-KSM.05.ah
1988 DEC 17	1	TSG-KSM-Z	48.6	BRV.19881217.0419.TSG-KSM.01.ah
1988 DEC 17	8	TSG-KS-N	4511	BRV.19881217.0419.TSG-KS.08.ah
1988 DEC 17	9	TSG-KS-E	4533	BRV.19881217.0419.TSG-KS.09.ah
1988 DEC 17	6	SS-SKM-Z	22.0	BRV.19881217.0419.SS-SKM.06.ah
1988 DEC 17	8	SS-SKM-N	2047	BRV.19881217.0419.SS-SKM.08.ah
1988 DEC 17	9	SS-SKM-E	1999	BRV.19881217.0419.SS-SKM.09.ah
1989 MAY 08	3	TSG-KSM-Z	1009	BRV.19890508.0005.TSG-KSM.03.ah
1989 MAY 08	4	TSG-KSM-N	1028	BRV.19890508.0005.TSG-KSM.04.ah
1989 MAY 08	5	TSG-KSM-E	1030	BRV.19890508.0005.TSG-KSM.05.ah
1989 MAY 08	7	TSG-KS-Z	4565	BRV.19890508.0005.TSG-KS.07.ah
1989 MAY 08	8	TSG-KS-N	4511	BRV.19890508.0005.TSG-KS.08.ah
1989 MAY 08	9	TSG-KS-E	4533	BRV.19890508.0005.TSG-KS.09.ah
1989 MAY 08	22	TSG-DSM-Z	1013	BRV.19890508.0005.TSG-DSM.22.ah
1989 MAY 08	23	TSG-DSM-N	1007	BRV.19890508.0005.TSG-DSM.23.ah
1989 MAY 08	24	TSG-DSM-E	1011	BRV.19890508.0005.TSG-DSM.24.ah
1990 AUG 16	1	TSG-KSM-Z	48.07	BRV.19900816.0503.TSG-KSM.01.ah
1990 AUG 16	8	TSG-KS-N	4511	BRV.19900816.0503.TSG-KS.08.ah
1990 AUG 16	9	TSG-KS-E	4533	BRV.19900816.0503.TSG-KS.09.ah
1990 AUG 16	7	SS-SKM-Z	2000(g)	BRV.19900816.0503.SS-SKM.07.ah
1990 AUG 16	8	SS-SKM-N	2000(g)	BRV.19900816.0503.SS-SKM.08.ah
1990 AUG 16	9	SS-SKM-E	2000(g)	BRV.19900816.0503.SS-SKM.09.ah
1990 AUG 16	22	TSG-DSM-Z	1013	BRV.19900816.0503.TSG-DSM.22.ah
1990 AUG 16	23	TSG-DSM-N	1007	BRV.19900816.0503.TSG-DSM.23.ah
1990 AUG 16	24	TSG-DSM-E	1011	BRV.19900816.0503.TSG-DSM.24.ah
1990 OCT 24	1	TSG-KSM-Z	48.07	BRV.19901024.1502.TSG-KSM.01.ah
1990 OCT 24	8	TSG-KS-N	4511	BRV.19901024.1502.TSG-KS.08.ah
1990 OCT 24	9	TSG-KS-E	4533	BRV.19901024.1502.TSG-KS.09.ah

1990 OCT 24	19	TSG-DS-Z	48.8	BRV.19901024.1502.TSG-DS.19.ah
1990 OCT 24	20	TSG-DS-N	48.0	BRV.19901024.1502.TSG-DS.20.ah
1990 OCT 24	21	TSG-DS-E	47.6	BRV.19901024.1502.TSG-DS.21.ah

(a) Seismic system used and their gains for each trace were provided by Karim Khaidarov and Aborin at the Borovoye Observatory via Vitaly Adushkin at the Institute for Dynamics of Geosphere, Moscow during May 1991. Paul Richards checked each channel listing while he visited BRV station during August 1991.

(b) Gain is given as unit/micron, since most of the seismic systems at BRV have nearly flat amplitude responses to *ground displacement* in their pass-bands.

(c) KOD system, which operated between 1966-Nov 1973, has polarity reversal on all the channels. This polarity reversal is indicated by using negative gain.

(d) Listed gains are questionable, nominal gain of 5.0 for these channels should be used.

(e) This is unknown channel name.

(f) Gain is not given in Khaidarov's list and nominal gains of 50.0 for these channels are assumed.

(g) Gain is not given in Khaidarov's list and nominal gains of 2000.0 are assumed.

Table 3. Instrument Characteristics at BRV(*)

System	Seismo- meter	Channel	Ts(1) (s)	Ds(2)	Sm(3)	fn(4) (Hz)	dt(5) (msec)	Channel number
KOD	SKM-3	HG(6)	3.5	1	3000	2.0	30	1,2,3
		LG(Z)			300	2.0	30	-
	SKD		30.0	0.71				-
STsR-SS	SKM-3	HG (76-80) LG(Z)	2.0	0.5	2000	1.8	24	7,8,9
					1000	1.8	32	7,8,9
					200	1.8	32	1
					20	1.8	96	6
	SKD	HG	25.0	0.71	5 0.5	0.14 0.14	192 192	2,3,4 -
STsR-TSG	KS	HG (1977)	1.5	0.71	4500	2.37	26	7,8,9
					2000	2.37	26	7,8,9
					1000	2.37	26	4,5
	KSM	HG LG(Z)	1.5	0.5	100000	1.43	26	10,11,12
					1000	1.43	26	3
	KSVM	HG(Z) LG(Z)	1.5	0.5	4600	1.43	26	2
					50	1.43	26	1
	DS	HG	20.0	0.71	50	0.1	312	19,20,21
	DSM	HG LG	28.0	0.71	1000	0.07	312	22,23,24
					10	0.07	312	15,16,17
ASSTs	SSM-S		2.0	-	250	-	-	-

(*) KOD system operated from 1966-Nov 1973 and had polarity reversal on all channels, STsR system is operating from Feb 1973 to present, and ASSTs is operating from Apr 1990 to present.

(1) Ts = Seismometer natural period in second.

(2) Ds = Seismometer damping constant, critical damping = 0.71.

(3) Sm = Nominal sensitivity (gain) in count/micron for ground displacement.

(4) fn = Normalization frequency where nominal sensitivity is measured.

(5) dt = Sampling interval in millisecond.

(6) HG is actually the base channel and not necessarily a high-gain, LG = low-gain channels and (Z) indicates that it is only vertical component. N.B., Nominal gains seem to have been changed from time to time, for example, during 1976-1980 data on SS-SKM channels and on 1977 data for TSG-KS channels.

Tar.tape.list

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rw-r--r--7602/7602    26816 Mar  2 18:13 1992 Text/Brv.Data.Text
rw-r--r--7602/7602      292 Mar  2 18:16 1992 Text/Read.me
rwxr-xr-x7602/7602      0 Mar  2 18:13 1992 AH/
rw-r--r--7602/7602    42040 Feb 26 18:13 1992 AH/BRV.19690501.0402.KOD-SKM.01.ah
rw-r--r--7602/7602    42040 Feb 26 18:13 1992 AH/BRV.19690501.0402.KOD-SKM.03.ah
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rw-r--r--7602/7602    13368 Feb 26 18:16 1992 AH/BRV.19890508.0005.TSG-DSM.22.ah
rw-r--r--7602/7602    13368 Feb 26 18:16 1992 AH/BRV.19890508.0005.TSG-DSM.23.ah
rw-r--r--7602/7602    13368 Feb 26 18:16 1992 AH/BRV.19890508.0005.TSG-DSM.24.ah
rw-r--r--7602/7602   140344 Feb 26 18:16 1992 AH/BRV.19890508.0005.TSG-KS.07.ah
rw-r--r--7602/7602   140344 Feb 26 18:16 1992 AH/BRV.19890508.0005.TSG-KS.08.ah
rw-r--r--7602/7602   140344 Feb 26 18:16 1992 AH/BRV.19890508.0005.TSG-KS.09.ah
rw-r--r--7602/7602   140344 Feb 26 18:16 1992 AH/BRV.19890508.0005.TSG-KSM.03.ah
rw-r--r--7602/7602   140344 Feb 26 18:16 1992 AH/BRV.19890508.0005.TSG-KSM.04.ah
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rw-r--r--7602/7602     8248 Feb 26 18:14 1992 AH/BRV.19770901.0304.TSG-DS.21.ah
rw-r--r--7602/7602    54328 Feb 27 13:30 1992 AH/BRV.19800914.0244.SS-SKM.01.ah
rw-r--r--7602/7602    54328 Feb 26 18:14 1992 AH/BRV.19780829.0238.SS-SKM.08.ah
rw-r--r--7602/7602    54328 Feb 26 18:14 1992 AH/BRV.19780829.0238.SS-SKM.09.ah
rw-r--r--7602/7602   140344 Feb 26 18:14 1992 AH/BRV.19870605.0503.TSG-KSM.08.ah
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rw-r--r--7602/7602     8248 Feb 26 18:15 1992 AH/BRV.19880914.0400.TSG-DS.21.ah
rw-r--r--7602/7602    75832 Feb 26 18:15 1992 AH/BRV.19880914.0400.TSG-KS.08.ah
rw-r--r--7602/7602    75832 Feb 26 18:15 1992 AH/BRV.19880914.0400.TSG-KS.09.ah
rw-r--r--7602/7602    75832 Feb 26 18:15 1992 AH/BRV.19880914.0400.TSG-KSM.01.ah
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rw-r--r--7602/7602    71736 Feb 26 18:15 1992 AH/BRV.19881112.0331.SS-SKM.08.ah
rw-r--r--7602/7602    71736 Feb 26 18:15 1992 AH/BRV.19881112.0331.SS-SKM.09.ah

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Tar.tape.list

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rw-r--r--7602/7602	151608	Feb	26	18:14	1992	AH/BRV.19831006.1003.SS-SKM.09.ah
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rw-r--r--7602/7602	151608	Feb	26	18:14	1992	AH/BRV.19841003.0603.SS-SKM.07.ah
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rw-r--r--7602/7602	151608	Feb	26	18:14	1992	AH/BRV.19841219.0603.SS-SKM.07.ah
rw-r--r--7602/7602	151608	Feb	26	18:14	1992	AH/BRV.19841219.0603.SS-SKM.08.ah
rw-r--r--7602/7602	151608	Feb	26	18:14	1992	AH/BRV.19841219.0603.SS-SKM.09.ah
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rw-r--r--7602/7602	13368	Feb	26	18:14	1992	AH/BRV.19870605.0503.TSG-DS.20.ah
rw-r--r--7602/7602	13368	Feb	26	18:14	1992	AH/BRV.19870605.0503.TSG-DS.21.ah
rw-r--r--7602/7602	140344	Feb	26	18:14	1992	AH/BRV.19870605.0503.TSG-KSM.01.ah
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rw-r--r--7602/7602	121912	Feb	26	18:15	1992	AH/BRV.19880507.2254.SS-SKM.09.ah
rw-r--r--7602/7602	11320	Feb	26	18:15	1992	AH/BRV.19880507.2254.TSG-DS.19.ah
rw-r--r--7602/7602	11320	Feb	26	18:15	1992	AH/BRV.19880507.2254.TSG-DS.20.ah
rw-r--r--7602/7602	11320	Feb	26	18:15	1992	AH/BRV.19880507.2254.TSG-DS.21.ah
rw-r--r--7602/7602	112696	Feb	26	18:15	1992	AH/BRV.19880507.2254.TSG-KS.08.ah
rw-r--r--7602/7602	112696	Feb	26	18:15	1992	AH/BRV.19880507.2254.TSG-KS.09.ah
rw-r--r--7602/7602	112696	Feb	26	18:15	1992	AH/BRV.19880507.2254.TSG-KSM.01.ah
rw-r--r--7602/7602	112696	Feb	26	18:16	1992	AH/BRV.19881204.0524.TSG-KS.08.ah
rw-r--r--7602/7602	112696	Feb	26	18:16	1992	AH/BRV.19881204.0524.TSG-KS.09.ah
rw-r--r--7602/7602	112696	Feb	26	18:16	1992	AH/BRV.19881204.0524.TSG-KSM.01.ah
rw-r--r--7602/7602	112696	Feb	26	18:16	1992	AH/BRV.19881204.0524.TSG-KSM.03.ah
rw-r--r--7602/7602	112696	Feb	26	18:16	1992	AH/BRV.19881204.0524.TSG-KSM.04.ah
rw-r--r--7602/7602	112696	Feb	26	18:16	1992	AH/BRV.19881204.0524.TSG-KSM.05.ah
rw-r--r--7602/7602	151608	Feb	26	18:16	1992	AH/BRV.19900816.0503.SS-SKM.07.ah
rw-r--r--7602/7602	151608	Feb	26	18:16	1992	AH/BRV.19900816.0503.SS-SKM.08.ah
rw-r--r--7602/7602	151608	Feb	26	18:16	1992	AH/BRV.19900816.0503.SS-SKM.09.ah
rw-r--r--7602/7602	13368	Feb	26	18:16	1992	AH/BRV.19900816.0503.TSG-DSM.22.ah
rw-r--r--7602/7602	13368	Feb	26	18:16	1992	AH/BRV.19900816.0503.TSG-DSM.23.ah
rw-r--r--7602/7602	13368	Feb	26	18:16	1992	AH/BRV.19900816.0503.TSG-DSM.24.ah
rw-r--r--7602/7602	140344	Feb	26	18:16	1992	AH/BRV.19900816.0503.TSG-KS.08.ah
rw-r--r--7602/7602	140344	Feb	26	18:17	1992	AH/BRV.19900816.0503.TSG-KS.09.ah
rw-r--r--7602/7602	140344	Feb	26	18:17	1992	AH/BRV.19900816.0503.TSG-KSM.01.ah
rw-r--r--7602/7602	11320	Feb	26	18:17	1992	AH/BRV.19901024.1502.TSG-DS.19.ah
rw-r--r--7602/7602	11320	Feb	26	18:17	1992	AH/BRV.19901024.1502.TSG-DS.20.ah

92/03/02
18:39:24

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Tar.tape.list

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rw-r--r--7602/7602 11320 Feb 26 18:17 1992 AH/BRV.19901024.1502.TSG-DS.21.ah
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rw-r--r--7602/7602 112696 Feb 26 18:17 1992 AH/BRV.19901024.1502.TSG-KS.09.ah
rw-r--r--7602/7602 112696 Feb 26 18:17 1992 AH/BRV.19901024.1502.TSG-KSM.01.ah
rw-r--r--7602/7602 57400 Feb 26 18:15 1992 AH/BRV.19880213.0306.TSG-KS.09.ah
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