CHEMICAL EXPLOSIONS DURING 1961 – 1988 ON THE SEMIPALATINSK TEST SITE, KAZAKHSTAN

Vitaly I. Khalturin[1], Tatyana G. Rautian[1], and Paul G. Richards[2]

[1]Institute of Physics of the Earth, Russian Academy of Sciences, Moscow
[2]Lamont-Doherty Earth Observatory, Palisades, NY 10964,
and Department of Earth and Environmental Sciences, Columbia University

Underground nulcear explosions at the Semipalatinsk Test Site (STS) have been described in numerous publications (for example: Lilwall and Farthing, 1990; Ringdal et al.,1992; and Khalturin et al., 2000). An earthquake very near this test site in 1976 has also been studied in some detail (Pooley et al., 1983), and two other earthquakes in the region were described by Khalturin et al. (1994 and 2000). But chemical explosions at STS have received less attention. Here, we list the origin time, location, and magnitude of 29 chemical explosions carried out at STS during the Soviet era. They were carried out by Soviet military organizations for construction projects, and for technical and scientific studies. Most of them were small, with seismic magnitudes in the range 3.2 to 4.4. To date there have not been any official announcements or publication, of technical details concerning these chemical explosions at STS.

These chemical explosions generated seismic signals which were recorded regionally at stations as described in our previous papers (Khalturin et al., 1994 and 2000), which emphasized the study of 340 underground nuclear tests at STS. The signals from these 29 seismic events have all the characteristics of explosions, and we identify them as chemical explosions in part by comparing their origin times and dates with the list of nuclear explosion dates contained in Russian official publications (Mikhailov et al., 1996; USSR Nuclear Tests, 1997;note that these publications do not contain origin time information on nuclear explosions, but such origin times are given by Khalturin et al., 2000, on the basis of seismic data).

Parameters of the 29 chemical explosions are given in Table 1. More than half of them were assumed in some publications during the late 1980s to be underground nuclear tests at STS. It is of course appropriate to list all candidate nuclear explosions in projects that set out to evaluate monitoring capability.

In Table 1, estimated origin time, coordinates and K values were obtained from an analysis of observations of the Complex Seismological Expedition of the Soviet Academy of Sciences. The magnitude value m(NOR) refers to NORSAR magnitudes obtained from Norway via F. Ringdal [personal communication, 1994]; magnitudes in parentheses ( ) were assigned by the Swedish station at Hagfors (HFS) and are known typically to be significantly higher than m(NOR) values; and $mb(K)$ is the body wave magnitude calculated from energy class K using the relationship between magnitude and energy class

$$mb(K) = 0.46\ K\ -\ 0.64,$$

as derived by Khalturin et al. (1998). We do not claim this Table is a complete list at these magnitudes.

Table 1.

Date	Time	Lat	Long	K	m(NOR)	mb(K)	Notes
1961 Jun 05	03:50:00	49.77	77.98	11.0	-	4.42	A
1973 Mar 23	06:30:00	49.94	79.06	9.53	3.7	3.74	
1974 Sep 27	07:34:00	49.98	79.00	10.47	4.0	4.16	
1978 Jul 31	08:00:00	50.42	77.87	10.2	3.9	4.05	B
1979 May 24	04:07:00	49.94	78.79	10.33	3.9	4.05	SR-1
1979 Sep 14	07:33:00	49.95	78.84	10.75	4.4	4.30	SR-2
1979 Sep 15	04:07:00	49.94	78.82	8.85	3.8	3.44	
1980 Jul 13	08:10:00	49.91	78.84	10.33	(5.0)	4.10	SR-3
1980 Sep 20	10:40:01	49.96	78.88	9.83	3.8	3.88	SR-4
1980 Sep 30	05:57:12	49.95	78.40	-	3.6	-	SR-5
1980 Sep 30	05:57:17	49.95	78.40	11.03	4.4	4.42	SR-6
1980 Nov 06	17:42:58	50.14	78.76	9.17	3.9	3.56	
1981 May 28	04:08:28	50.00	78.00	7.70	-	2.90	
1981 Jun 05	03:22:18	49.84	78.72	10.30	4.0	4.10	SR-7
1981 Jul 05	03:59:14	49.87	78.99	10.47	(4.6)	4.17	SR-8
1981 Sep 30	12:55:10	49.94	78.90	10.70	4.3	4.28	SR-9
1981 Nov 19	05:57:14	50.11	78.95	9.60	4.0	3.78	
1982 Jun 11	10:59:07	49.90	77.90	10.65	4.1	4.26	SR-10
1982 Jul 12	10:29:18	49.90	77.90	10.67	3.9	4.27	SR-11
1982 Sep 04	05:47:17	50.06	78.56	9.47	3.6	3.72	SR-12
1982 Sep 15	04:33:19	49.85	78.85	10.86	4.2	4.36	SR-13
1983 Jul 28	03:41:28	50.07	78.60	10.74	4.3	4.34	SR-14
1984 Jun 23	02:57:16	49.92	78.93	11.06	4.4	4.44	SR-15
1984 Sep 15	06:15:10	49.99	78.88	11.17	-	4.48	C and SR-16
1985 Jun 27	11:57:04	49.78	77.97	8.5	-	3.27	D
1987 Jun 29	04:55:08	49.78	77.97	8.5	-	3.27	D
1987 Sep 02	09:27:05	50.00	70.34	-	2.7	-	E
1987 Sep 16	07:30:01	49.86	78.73	10.64	4.3	4.26	SR-17
1988 Sep 26	07:45:04	50.08	78.80	10.41	4.3	4.15	F

Notes on Table 1:

A — Fully contained explosion with a yield of 600 tons of TNT, carried out in a Degelen Mountain tunnel prior to the start of nuclear testing (Sultanov et al. 1995). Goals included calibration of a seismic network and estimation of the expected seismic signal strength at different distances.

B — Large experimental chemical explosion on the surface with a yield of 5000 tons.

C — This chemical explosion has been wrongly listed as an underground nuclear test, in some cases with *mb* = 5.04; for example see Lilwall and Farthing (1990), and Ringdal, Marshall, and Alewine (1992). For this chemical explosion, *mb*(ISC) = 4.7, *mb*(HFS) = 5.2.

D — These two experimental chemical explosions, each of 500 tons of TNT, were conducted by the Institute of Dynamics of the Geospheres (IDG) at the same place on the surface of Degelen Mountain near the mouth of tunnel #160 (49.7841° N, 77.96722° E). See Adushkin et al. (1997).
E — Chemical explosion (yield 20 tons, depth 25 m) carried out in the Degelen sub-area during the Joint US-Soviet Experiment of the USSR Academy of Sciences and the US Natural Resources Defense Council (see Given et al., 1990).
F — Hansen et al. (1990) assumed this chemical explosion was an underground nuclear test in their study of the stability of RMS *Lg*.
SR — Sykes and Ruggi (1986, 1989) list all these 15 chemical explosions as underground nuclear tests at STS with the following *mb* values:

```
 1 - 4.9;    2 - 5.2;    3 - 5.0;    4 - 4.9;    5 - 4.6;    6 - 5.2;
 7 - 4.7;    8 - 4.6;    9 - 4.6;   10 - 4.6;   11 - 4.6;   12 - 4.1;
13 - 5.0;   14 - 5.0;   15 - 4.4;   16 - 5.2;   17 - 5.0.
```

Some if not all of these magnitudes are from the Hagfors Observatory (HFS). On average, HFS magnitudes are larger than NORSAR magnitudes by about 0.6 – 0.8 magnitude units.

These 29 chemical explosions are useful as seismic events suitable for generating data that allow the evaluation of detection capability, and of various methods of discrimination between single-fired explosions and earthquakes.

Acknowledgements

We thank Dr. Frode Ringdal of NORSAR and Dr. Yuri Kopnichev of CSE, who made considerable efforts to find detections and assign magnitudes for particular events here.

References

Adushkin, V., Pernik, L., and Spivak, A. (1997), *Degelen Mountain chemical explosion cratering experiment*, Institute for Dynamics of the Geospheres, Technical Report No 97-3011 to DSWA, 110 p.

Given, H.K., Tarasov, N.T., Zhuravlev, V.V., Vernon, F.L., Berger, J., and Nersesov, I.L., (1990), *High-frequency seismic observation in Eastern Kazakhstan, USSR, with emphasis on chemical explosion experiments*, J. Geophys. Res., **95**, 295 – 307.

Hansen, R.A., Ringdal, F., and Richards, P.G. (1990*), The stability of RMS Lg measurements and their potential for accurate estimation of the yields of Soviet underground nuclear explosions*, Bull. Seism. Soc. Am., **80**, 2106 – 2126.

Khalturin, V.I., Rautian, T.G., and Richards, P.G. (1994), *A study of small explosions and earthquakes during 1961-1989 near the Semipalatinsk Test Site, Kazakhstan*, technical report for subcontract B239589 with Regents of Univ. of Calif., 64 p.

Khalturin, V.I., Rautian, T.G., and Richards, P.G. (1998), *The seismic signal strength of chemical explosions*, Bull. Seism. Soc. Am., **88**, 1511 – 1524.

Khalturin, V.I., Rautian, T.G., and Richards, P.G. (2000), *A study of small magnitude seismic events during 1961 – 1989 on and near the Semipalatinsk Test Site, Kazakhstan*, paper accepted for publication, Pure and Applied Geophysics, 2000.

Lilwall, R.C., and Farthing, J. (1990), *Joint epicentre determination of Soviet underground nuclear explosions 1973-1989 in Eastern Kazakhstan*, AWE Report No. O 12/90, H.M. Stationery Office, London.

Mikhailov, V.N. (editor) and 14 co-authors, (1996), *USSR Nuclear Weapons Tests and Peaceful Nuclear explosions, 1949 through 1990*, RFNC-VNIIEF, Sarov, 96 p.

Pooley, C.I., Douglas, A., and Pearce, R.G. (1983*), The seismic disturbance of 1976 March 20, East Kazakhstan: earthquake or explosion?* Geophys. J.R. Astr. Soc., **74**, 621 – 631.

Ringdal, F., Marshall, P.D., and Alewine, R.W. (1992), *Seismic yield determination of Soviet underground nuclear explosions at the Shagan River test site*, Geophys. J. Int., **109**, 65 – 77.

Sultanov, J.J., Adushkin, V.V., Danilova, T.V., Kaazik, P.B., Kuznetsov, O.P., Nedoshivin, N.I., and Rubinshtein, N.D. (1995), Completion of data base of PNE and large-scale chemical blasts conducted inside the territory of FSU. Institute for Dynamics of Geospheres Report to IRIS, subcontract 201, 144 p.

Sykes, L. and Ruggi, S. (1986), Soviet Nuclear Testing. Natural Resources Defense Council, Working Paper NWD 86-4, November 1986.

Sykes, L. and Ruggi, S. (1989), Soviet Nuclear Testing. Chapter 10 in *Nuclear Weapons Databook*, Vol.IV, eds. Cochran, T.B., Arkin, W.M., Norris, R.S., and Sandes, J.I.

USSR Nuclear Tests (1997), Mikhailov, V.N. (editor) and 29 co-authors, UZDAT Publishing House, Moscow, 248 p (in Russian).

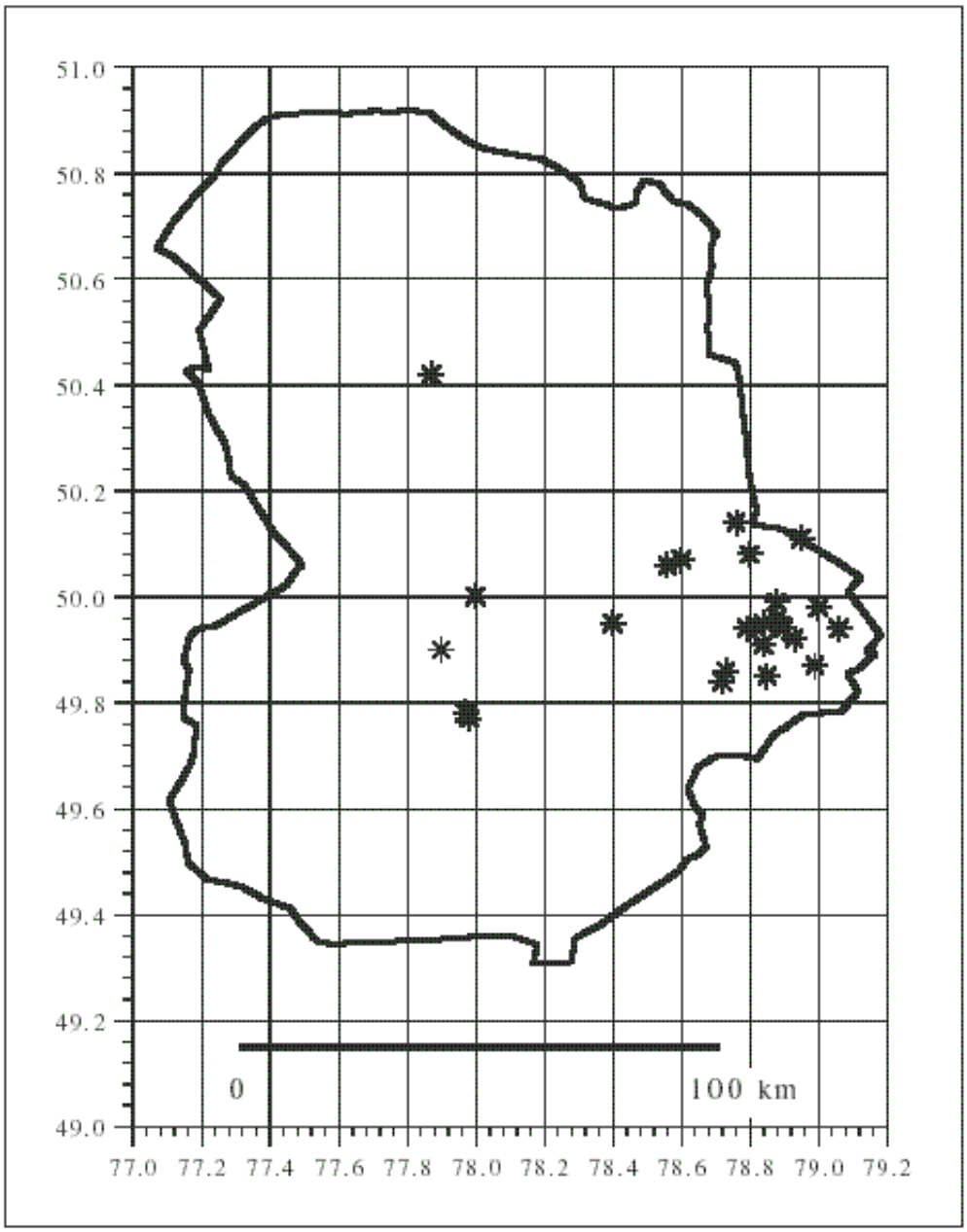

Figure 1. The locations of 29 chemical explosions, given in Table 1, are shown on a map indicating the boundary of the Semipalatinsk Test Site.