

Metadata for events in the Group 2 Reference Event List

Event name	Event origin sources	Arrival sources	#	GT
<i>nuclear explosions</i>			459	0-10
Balapan, Kazakhstan	Belyashova, 1999, Bocharov et al., 1989, Lilwall et al, 1990, Murphy and Jenab, 1992	HDC, IDG, LDEO, EHB, ISC	99	1
Degelen, Kazakhstan	Bocharov et al., 1989, Lilwall et al, 1990	EHB, HDC, IDG, LDEO, ISC	151	1
India	Barker et al., 1999, Gupta and Pabian, 1996	EHB, REB	2	0-5
Lop Nor, China	Bhattacharyya et al, 2002, Douglas et al, 1993, Gupta, 1995, Gupta and Rich, 1995, Fisk, 2003	EHB, HDC, ISC	29	0-5
Novaya Zemlya, Russia	Khristoforov, 1996, Marshall et al, 1994, Richards, 2000	EHB, IDG, ISC, HDC	42	1-5
Peaceful Nuclear Explosions, USSR	Sultanov et al., 1995	EHB, Murphy et al., 2002, IDG, ISC, LDEO, HDC	98	1-10
Pakistan	Barker et al., 1999, Albright et al, 1998	EHB, GII, REB	1	5
Sahara, Algeria	Bolt, 1976, Duclaux et al, 1970	HDC	13	0
Semipalatinsk, Kazakhstan	Bocharov et al., 1989, Lilwall et al, 1990	EHB, IDG, LDEO, HDC	24	0-5
<i>calibration shots and seismic profiles</i>			216	0
Balapan shots, Kazakhstan	Jih and Wagner 2000, Kazakhstan	Multimax, REB	7	0
CELEBRATION2000	Guterch et al., 2001	Austria, Hungary, Slovenia, NEIC, REB	147	0
Dead Sea Shots	Gitterman and Shapira, 2001	GII, REB	3	0
European GeoTraverse	Aichroth et al., 1990, Bunes et al., 1990, Egger et al., 1998	EHB, ISC	6	0
EUROBRIDGE	EUROBRIDGE Working Group, 1999, Kvaerna et al., 2000	REB	25	0
Kola calibration shots, Russia	Russia	Finland, Norway, REB	3	0

Event name	Event origin sources	Arrival sources	#	GT
Negev calibration shot, Israel	GII	GII	1	0
POLONAISE97	Guterch et al., 1999	REB	15	0
VRANCEA99	Popa, 2001	GII, Popa, 2001	9	0
<i>mining events, accidents</i>			<i>202</i>	<i>0-5</i>
Abakan and Kuzbass mining blasts, Russia	Emanov et al., 1999	REB	2	5
Ammunition explosion, Switzerland	Switzerland	Czech Republic, France, Germany, Spain, Switzerland, UK	1	0
Factory explosion, Thailand	REB	REB	1	5
Mine explosions, Fennoscandia	Israelsson, 1999, Sweden	REB	176	2-5
Mine tremors, Poland	Gibowicz, 2000	REB	13	1-2
Quarry blasts, Kola peninsula, Russia	NORSAR, 2000	NORSAR, 2000	5	1-2
Quarry blasts, Israel	GII	Israel	2	1-2
Solikamsk mine collapse, Ural, Russia	ISC	ISC	1	2
Teutschenthal salt mine collapse, Germany	Germany	Croatia, Finland, France, Germany, Hungary, Italy, Netherlands, Norway, REB, Slovenia, Switzerland, UK	1	2
<i>earthquakes</i>			<i>499</i>	<i>5-15</i>
EHB	Engdahl et al, 1998	EHB, GII, LLNL	432	5
IGN bulletin, Spain	Chan et al., 2000	EHB, GII, Spain	9	5
Fennoscandia	Grant, 1993	Grant, 1993	10	5
Revda, Norway	NORSAR, 2000	NORSAR, 2000	3	5
Caucasus	Gabsatarova et al., 2002	Kirichenko et al., 2001	6	5
Eastern Pyrenees	Roca, 2000	EHB, Roca, 2000	2	5
Gilad and Golan, Israel	GII	GII, Israel	2	5
Lake Magadi, Kenya	Ibs-von Seht et al., 2001	Ibs-von Seht et al., 2001	2	5

Event name	Event origin sources	Arrival sources	#	GT
Mid-ocean ridges (Carlsberg ridge, Mid-Atlantic ridge)	Pan et al., 2000	EHB, GII, LLNL	29	15
Minagish, Kuwait	Bou-Rabee, 2000	Bou-Rabee, 2000	1	10
Siberia, Russia	Emanov et al., 1999	REB	1	5
Umbria-Marche, Italy	Amato et al., 1998	GII, Italy	1	5
Valentine day earthquake, Pakistan	Seeber and Armbruster, 1979	ISC	1	5
<i>event clusters</i>			<i>587</i>	<i>5-10</i>
Adana, Turkey	GII, Engdahl and Bergman, 2001, Engdahl et al., 2002	HDC, GII	4(16)	5-7
Ancey, France	Thouvenot et al., 1998, Israelsson, 2001	Croatia, Czech Republic, France, Germany, Hungary, JHD, Italy, Netherlands, REB, UK, Spain, Switzerland	1(9)	5-7
Bhuj, India	Bodin et al., 2001, Engdahl and Bergman, 2001, Engdahl et al., 2002	HDC	6(73)	5-7
Chamoli, India	Saikia and Ichinose, 2001, Engdahl and Bergman, 2001, Engdahl et al., 2002	HDC	8(58)	5-7
Duzce, Turkey	GII, Engdahl and Bergman, 2001, Engdahl et al., 2002	HDC, GII	3(21)	5-7
Erzincan, Turkey	Fuenzalida et al., 1997b, Engdahl and Bergman, 2001, Engdahl et al., 2002	HDC, GII, LLNL	3(6)	5-7
Garm, Tajikistan	Pavlis, 2000, Engdahl and Bergman, 2001, Engdahl et al., 2002	HDC	4(22)	5-7
Gubal island, Egypt	Hurukawa et al., 2001, Engdahl and Bergman, 2001, Engdahl et al., 2002	HDC, Hurukawa et al., 2001	1(25)	10
Gulf of Aden	Pan et al., 2000, Engdahl and Bergman, 2001, Engdahl et al., 2002	HDC, GII, LLNL	5(50)	10

Event name	Event origin sources	Arrival sources	#	GT
Gulf of Aqaba	GII, Engdahl and Bergman, 2001, Engdahl et al., 2002	HDC, GII	1(32)	5-7
Hoceima, Morocco	Gupta and Wagner, 2001, Engdahl and Bergman, 2001, Engdahl et al., 2002	HDC, GII	3(19)	5-7
Izmit, Turkey	GII, Engdahl and Bergman, 2001, Engdahl et al., 2002	HDC, GII	5(19)	5-7
Jiashi, China	Xu, 2000, Engdahl and Bergman, 2001, Engdahl et al., 2002	HDC	1(68)	10
Koyna, India	Gupta et al., 2002, Engdahl and Bergman, 2001, Engdahl et al., 2002	HDC	9(11)	5-7
Krn, Slovenia	Zivcic, 2000, Israelsson, 2001	EHB, JHD, REB	2(9)	5-7
Loja, Spain	Chan et al., 2000, Israelsson, 2001	EHB, JHD, Spain	4(10)	5-7
Racha, Georgia	Fuenzalida et al., 1997a, Engdahl and Bergman, 2001, Engdahl et al., 2002	HDC, GII	5(30)	5-7
Spitak, Armenia	Dorbath et al., 1992, Engdahl and Bergman, 2001, Engdahl et al., 2002	HDC, GII	2(9)	10
Tabas, Iran	Berberian, 1982, Engdahl and Bergman, 2001, Engdahl et al., 2002	HDC, LLNL	2(31)	10

Notes:

In the number of events column of the event clusters section the number given between the parentheses indicates the number of events promoted to GT level during the HDC/JHD analysis. All other events in the event clusters as well as single earthquakes were assigned a GT level based on the criteria of Bondár et al. (2004).

EHB: Engdahl et al, 1998; GII: Geophysical Institute of Israel; HDC: HypoCentroidal Decomposition; IDG: Institute for the Dynamics of the Geospheres, Moscow; ISC: International Seismological Centre; JHD: Joint Hypocentre Determination; LDEO: Lamont-Doherty Earth Observatory; LLNL: Lawrence-Livermore National Laboratory; NEIC: National Earthquake Information Center; REB: Reviewed Event Bulletin of the Prototype International Data Center.

REFERENCES

- Aichroth, B., S. Ye, J. Feddersen, M. Maistrello and R. Pedone, A compilation of data from the 1986 European Geotraverse Experiment (main line) from Genova to Kiel, *Geophysical Institute, Univ. Karlsruhe*, Open-File Report 90-1, 1990.
- Albright, D., C. Gay and F. Pabian, New details emerge on Pakistan's nuclear test site, EOM (<http://www.modernag.com/Common/Archives/DecemberJan/gay.htm>), 1998.
- Amato, A., A. Azzara, C. Chiarabba, G.B. Cimini, M. Cocco, M. di Bona, L. Margheriti, S. Mazza, F. Mele, G. Selvaggi, A. Basili, E. Boschi, F. Courboulex, A. Deschamps, S. Gaffet, G. Bittarelli, L. Chiaraluca, D. Piccinini and M. Ripepe, The 1997 Umbria-Marche, Italy, earthquake sequence: a first look at the main shocks and aftershocks, *Geophys. Res. Let.*, **25**, 2861-2864, 1998.
- Barker, B., M. Clark, P. Davis, M. Fisk, M. Hedlin, H. Israelsson, V. Khalturin, W-Y. Kim, K. McLaughlin, C. Meade, J. Murphy, R. North, J. Orcutt, C. Powell, P. Richards, R. Stead, J. Stevens, F. Vernon and T. Wallace, Monitoring nuclear tests, *Science*, **281**, 1967-1968, 1999.
- Belyashova, N.N., Table of locations of Balapan nuclear explosions newly mapped by NNCKR, *National Nuclear Center of Kazakhstan Republic*, pers. comm., 1999.
- Berberian, M., Aftershock tectonics of the 1978 Tabas-e-Golshan (Iran) earthquake sequence: a documented active thin- and thick-skinned tectonic case, *Geophys. J.R. astr. Soc.*, **68**, 499-530, 1982.
- Bergman, E.A. and E.R. Engdahl, Validation and generation of reference events by cluster analysis, *Seism. Res. Let.*, **72**, 3, 2001.
- Bhattacharyya, J., B. Kohl, H. Israelsson and B. Zuzolo, Lop Nor Underground Nuclear Explosions: Summary of Preferred Locations and Origin Times, *Center for Monitoring Research Technical Report*, CMR-02/01, 2002.

- Bocharov, V.S., S.A. Selentov and V.N. Michailov, Characteristics of 92 Underground Nuclear Explosions at the Semipalatinsk Test Site, *Atomaya Energia*, **87**, Issue 3, 1989 (in Russian).
- Bodin, P., S. Horton, A. Johnston, G. Patterson, J. Bollwerk, P. Rydelek, G. Steiner, C. McGoldrick, K.P. Budhbhatti, R. Shah and N. Macwan, Aftershocks of the India Republic Day earthquake: the MAEC/ISTAR temporary seismograph network, *EOS Trans. AGU*, **82**, S22a-07, 2001.
- Bolt, B.A., Nuclear Explosions and Earthquakes: The Parted Veil, *W.H. Freeman*, 1976.
- Bondár, I., S.C. Myers, E.R. Engdahl and E.A. Bergman, Epicenter accuracy based on seismic network criteria, *Geophys. J. Int.*, **156**, 483-496, doi: 10.1111/j.1365-246X.2004.02070.x, 2004.
- Bou-Rabee, F., Seismotectonics and earthquake activity in Kuwait, *J. Seismology*, **4**, 133-141, 2000.
- Buness, H., A compilation of data from the 1983 European Geotraverse Experiment from the Ligurian Sea to the Southern Alps, *Institute of Geophysics, Free University Berlin*, 1990.
- Chan, W., W. Rivers, I. Gupta and R. Wagner, Selection of Reference Events in Spain from IGN Bulletins, *Multimax Report*, 2000.
- Dorbath, L., C. Dorbath, L. Rivera, A. Fuenzalida, A. Cisternas, R. Tatevossian, J. Apteckman and S. Arefiev, Geometry, segmentation and stress regime of the Spitak (Armenia) earthquake from the analysis of the aftershock sequence, *Geophys. J. Int.*, **108**, 309-328, 1992.
- Douglas, A., P.D. Marshall and K.H. Jones, Body-wave magnitude and locations of explosions at the Chinese test site: 1967-1989, *Atomic Weapons Establishment, AWE Report No. O 12/93*, 1993.
- Duclaux, F. and L. Michaud, Conditions experimentales des tirs nucleaires souterrains Francais au Sahara, 1961-1966, *C.R. Acad. Sc. Paris*, **270**, Serie B, 189-192, 1970.

- Egger, A., M. Demartin, J. Ansorge, E. Banda and M. Maistrello, The gross structure of the crust under Corsica and Sardinia, *Tectonophysics*, **150**, 363-389, 1988.
- Emanov, A.F., A.G. Filina, V.I. Khalturin, W-Y. Kim, and P.G. Richards, Earthquakes and large mining blasts in Southwestern Siberia, Russia, *1st Workshop on IMS Location Calibration*, Oslo, Norway, 12-14 January 1999.
- Engdahl, E.R., R.D. van der Hilst, and R.P. Buland, Global teleseismic earthquake relocation with improved travel times and procedures for depth determination, *Bull. Seism. Soc. Am.*, **88**, 722-743, 1998.
- Engdahl, E.R. and E.A. Bergman, Validation and generation of reference events by cluster analysis, *Proc. 23rd Seismic Research Review*, 205-214, Jackson Hole, USA, October 2-5, 2001.
- EUROBRIDGE Seismic Working Group, Seismic velocity structure across the Fennoscandia-Sarmatia suture of the East European craton beneath the EUROBRIDGE profile through Lithuania and Belarus, *Tectonophysics*, **314**, 193-217, 1999.
- Fisk, M.D., Accurate locations of nuclear explosions at the Lop Nor test site using cross-correlated seismograms and Ikonos satellite imagery, *Bull. Seism. Soc. Am.*, **92**, 2911-2925, 2002.
- Fuenzalida, H., L. Rivera, H. Haessler, D. Legrand, H. Philip, L. Dorbath, D. McCormack, S. Arefiev, C. Langer and A. Cisternas, Seismic source study of the Racha-Dzhava (Georgia) earthquake from aftershocks and broadband teleseismic body-wave records: and example of active nappe tectonics, *Geophys. J. Int.*, **130**, 29-64, 1997a.
- Fuenzalida, H., L. Dorbath, H. Ediyogan, A. Barka, L. Rivera, H. Haessler, H. Philip and N. Lyberis, Mechanism of the 1992 Erzincan earthquake and its aftershocks, tectonics of the Erzincan basin and decoupling on the North Anatolian fault, *Geophys. J. Int.*, **129**, 1-28, 1997b.
- Gabsatarova, I.P., O.Y. Starovoit, Y.A. Kraev and V.V. Kirichenko, Selection of candidate reference events in the Northern Caucasus region, *4th Workshop on IMS Location Calibration*, Oslo, Norway, 22-26 April, 2002.

Gibowicz, G., Mine tremors in Lubin, located by the Institute of Geophysics, Polish Academy of Sciences, Warsaw, Poland, *e-mail comm.*, 29 September, 2000.

Gitterman, Y. and A. Shapira, Dead Sea seismic calibration experiment contributes to CTBT monitoring, *Seism. Res. Lett.*, **72**, 159-170, 2001.

Grant, L., J. Coyne, and F. Ryall, CSS Ground-Truth Database: Version 1 handbook, *CSS Technical Report C93-05*, 1993.

Gupta, V., Locating nuclear explosions at the Chinese test site near Lop Nor, *Science and Global Security*, **5**, 205-244, 1995.

Gupta, V. and F. Pabian, Investigating the allegations of Indian nuclear test preparations in the Rajasthan desert, *Science and Global Security*, **6**, 1996.

Gupta, V., and D. Rich, Locating the denotation point of China first nuclear explosive test on 16 October 1964, *Int. J. Remote Sensing*, **17**, 1969-1974, 1996.

Gupta, I.N. and R.A. Wagner, Local network relocation of selected events from the EHBGT5 database, *Multimax Report*, 21 June, 2001 (http://g2calibration.cmr.gov/calibration/PDF/Multimax_EHB.pdf).

Gupta, H.K., P. Mandal, and R.K. Rastogi, How long will triggered earthquakes at Koyna, India continue?, *Current Science*, **82**, 202-210, 2002.

Guterch, A., M. Grad, H. Thybo, G.R. Keller and The POLONAISE Working Group, POLONAISE97 - an international seismic experiment between Precambrian and Variscan Europe in Poland, *Tectonophysics*, **314**, 101-121, 1999.

Guterch, A., M. Grad and A. Keller, Seismologists Celebrate the New Millenium with an Experiment in Central Europe, *EOS Trans. AGU*, **82**, 45, 2001.

Hurukawa, N., N. Seto, H. Inoue, K. Nishigami, I. Marzouk, A. Megahed, E.M. Ibrahim, H. Murukami, M. Nakamura, T. Haneda, S. Sugiyama, T. Ohkura, Y. Fujii, H.M. Hussein, A.S. Megahed, H.F. Mohammed, R. Abdel-Fattah, M. Mizoue, S. Hashimoto and D. Suetsugu, Seismological observations in and around the southern part of the Gulf of Suez, Egypt, *Bull. Seism. Soc. Am.*, **91**, 708-717, 2001.

Ibs-von Seht, M., S. Blumenstein, R. Wagner, D. Hollnack and J. Wohlenberg, Seismicity, seismotectonics and crustal structure of the southern Kenya Rift - new data from the Lake Magadi area, *Geophys. J. Int.*, **146**, 439-453, 2001.

Israelsson, H., Confirmed mine explosion in Fennoscandia, pers. comm., *Center for Monitoring Research*, 1999.

Israelsson, H., Notes from JHD analysis of some event clusters in Europe, *Center for Monitoring Research Memo*, 2001 (<http://g2calibration.cmr.gov/calibration/files/gt-jhdmemo.pdf>).

Jih, R-S., and R.A. Wagner Location calibration of Kazakhstan based on DTRA (US) – NNC (RoK) joint experiment (1997-1999) in the former Semipalatinsk teste site, *Proc. 22nd Seismic Research Symposium*, 2000.

Khristoforov, B., About the control of the underwater and above water nuclear explosions by hydroacoustic methods, *Institute for Dynamics of Geosphere, Russian Academy of Sciences Report*, SPC-95-4049, Moscow, October 1996.

Kirichenko, V.V., Y.A. Kraev, I.P. Gabsatarova and O. Starovoit, Selection of candidate reference events in the Northern Caucasus region, *Western Services Corp. and Geophysical Survey of the Russian Academy of Sciences Report*, September 2001. (http://g2calibration.cmr.gov/calibration/PDF/Caucasus_final.pdf).

Kvaerna, T., L. Taylor and J. Schweitzer, The Eurobridge profile - ground truth observations at the Fennoscandian arrays, *2nd Workshop on IMS Location Calibration*, Oslo, Norway, 20-24, March, 2000.

Lilwall, R.C. and J. Farthing, Joint Epicenter Determination of Soviet underground nuclear explosions 1973-89 at the Semipalatinsk Test Site, *Atomic Weapons Establishment*, AWE Report No. O 12/90, 1990.

Marshall, P.D., D. Porter, J.B. Young and P.A. Peachell, Analysis of short period seismograms from explosions at the Novaya Zemlya test site in Russia, *Atomic Weapons Establishment*, AWE Report No. O 2/94, 1994.

McLaughlin, K., I. Bondár, X. Yang, J. Bhattacharyya, H. Israelsson, B. North, V. Kirichenko, R. Engdahl, M. Ritzwoller, A. Levshin, N. Shapiro, E. Bergman, M. Antolik, A. Dziewonski, G. Ekström, H. Ghalib, I. Gupta, R. Wagner, W. Chan, W. Rivers, A. Hofstetter, A. Shapira and G. Laske, Seismic location calibration in the Mediterranean, North Africa, Middle East and Western Eurasia, *Proc. 24th Seismic Research Review*, 340-350, Pointe Vedra Beach, USA October 2002.

Murphy, J. and Jenab, Development of a Comprehensive Seismic Yield Estimation System for Underground Nuclear Explosions, *Maxwell Technical Report*, PL-TR-92-2076, SSS-TR-92-13129, 1992.

NORSAR, Seismic calibration of the European Arctic ground truth events, *Special Technical Report No.5*, NORSAR, June 2000.

Pan, J., M. Antolik and A. Dziewonski, Locations of mid-oceanic earthquakes constrained by sea-floor bathymetry, *EOS Trans. AGU*, **81**, F868, 2000.

Pavlis, G., Reference event locations from a dense local network in Garm, Tajikistan, Indiana University, *pers. comm.*, 2000.

Popa, M., Shot locations during the VRANCEA99 experiment, *pers. comm.* 2001.

Richards, P.G., Accurate estimates of the absolute location of underground nuclear tests at the northern Novaya Zemlya Test Site, *2nd Workshop on IMS Location Calibration*, Oslo, Norway, 20-24, March, 2000.

Roca, A., Earthquake in the Eastern Pyrenees, located by the Institut Cartografic de Catalunya, Barcelona, Spain, *e-mail comm.* 19 October, 2000.

Saikia, C.K., G. Ichinose and C. Ji, Seismic event location strategy and path calibration in and around Indian subcontinent, *Proc. 23rd Seismic Research Review*, 343-354, Jackson Hole, USA, October, 2001.

Seeber, L. and J. Armbruster, Seismicity of the Hazara Arc in northern Pakistan: decollement vs basement faulting, in *Geodynamics of Pakistan*, eds. A. Farah and K. A. DeJong, Geological Survey of Pakistan, 131-142, 1979.

Sultanov, D.D., J.R. Murphy and Kh.D. Rubinstein, A seismic source summary for Soviet Peaceful Nuclear Explosions, *Bull. Seism. Soc. Am.*, **89**, 640-647, 1999.

Thouvenot, F., J. Frechet, P. Tapponier, J.-C. Thomas, B. Le Brun, G. Menard, R. Lacassin, L. Jenatton, J.-R. Grasso, O. Coutant, A. Paul and D. Hatzfeld, The ML 5.3 Epagny (French Alps) earthquake of 1996 July 15: a long-awaited event on the Vuache Fault, *Geophys. J. Int.*, **135**, 876- 892, 1998.

Xu, S., A review of information on seismic event location in China, *2nd Workshop on IMS Location Calibration*, Oslo, Norway, 20-24, March, 2000.

Yang, X., R. North, C. Romney, and P. Richards, Worldwide nuclear explosions, in *International Handbook of Earthquake and Engineering Seismology, Vol. 81B*, eds. W.H. Lee, H. Kanamori, P. Jennings, and C. Kisslinger, Academic Press, 2003b.

Zivcic, M., Earthquake from the Krn mountains aftershock sequence, located by JHD analysis by the Geophysical Survey of Slovenia, Ljubljana, Slovenia, *pers. comm*, 2000.