INL/EXT-06-11731

INL Seismic Monitoring Annual Report: January 1, 2005 – December 31, 2005

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R.G. Berg

September 2006

The INL is a U.S. Department of Energy National Laboratory
operated by Battelle Energy Alliance

Idaho National Laboratory

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Idaho Falls, Idaho 83415

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SUMMARY

During 2005, the Idaho National Laboratory (INL) recorded 2390 independent triggers from earthquakes both within the region and from around the world. 38 small to moderate size earthquakes ranging in magnitude from 3.0 to 5.7 occurred within and outside the 161-km (100-mile) radius of INL. Earthquakes activity occurred in areas that have experienced seismic activity in the past, the Basin and Range northwest of the INL, southwestern Montana, Yellowstone Park, Wyoming, Jackson, Wyoming, and southeastern Idaho.

INL recorded the July 26, 2005 body-wave magnitude (m_b) 5.7 Dillon, Montana earthquake and 100's of associated aftershocks. Local residents felt the earthquake and experienced minor damage. The m_b 5.7 main shock was located more than 170 km (105 miles) from INL facilities and was not felt. The main shock did not trigger any strong-motion accelerographs (SMAs) located within INL buildings. Free-field SMAs and accelerometers co-located with seismic stations recorded acceleration data. Peak horizontal and vertical accelerations range from 0.0077 to 0.0006 g.

There were 449 earthquakes with magnitudes up to 4.6 that occurred within the 161-km radius of the INL in the Basin and Range surrounding the eastern Snake River Plain (ESRP). No earthquakes occurred within the INL boundaries or the ESRP. The largest earthquake occurred on October 31, 2005 and had a moment magnitude (M_w) 4.6. It was located north of Leadore, Idaho at a distance of 100 km (62 miles) from INL. The earthquake did not trigger SMAs located within INL buildings. Free-field SMAs and accelerometers co-located at seismic stations recorded peak horizontal and vertical accelerations that ranged from 0.0003 to 0.0030 g.

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ACKNOWLEDGMENTS

We thank Don Fox for his review of the report. We especially appreciate Alan Marley's (BEA) support of the seismic computer systems. We also thank staff at the University of Utah Seismograph Stations, U. S. Geological Survey, Montana Bureau of Mines and Geology, and BYU-Idaho for their earthworm data shares.

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ACRONYMS

ANL	Argonne National Laboratory
BLM	Bureau of Land Management
CFA	Central Facilities Area
DAAS	Data Acquisition/Analysis System
DOE	Department of Energy
DSL	Digital Subscriber Line
EFS	Experimental Field Station
ESRP	Eastern Snake River Plain
GPS	Global Positioning System
INL	Idaho National Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
IRC	INL Research Center
LOFT	Loss of Fluid Test
MFC	Materials and Fuels Complex
NEIC	National Earthquake Information Center
NRF	Naval Reactor Facility
PBF	Power Burst Facility
P-wave	Compressional Wave
RTC	Reactor Technology Complex
RWMC	Radioactive and Waste Management Complex
S-wave	Shear Wave
SMA	Strong Motion Accelerograph
STC	Science and Technology Complex
TAN	Test Area North

TRA	Test Reactor Area
USGS	United States Geological Survey

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1. Introduction

The Idaho National Laboratory (INL) has accumulated 33 years of earthquake data (1972-2005). This report covers the earthquake activity from January 1, 2005 through December 31, 2005 within a 161-km (100-mile) radius from the center of the INL designated as 43° 39.00' N, 112° 47.00' W (Figure 1). The report briefly discusses earthquakes greater than magnitude 3.0 that have occurred around the local region. It discusses the instrumentation used to record earthquake data and how the data were analyzed. It also includes a discussion of continuous GPS (Global Positioning System) stations co-located at INL seismic stations in support of crustal deformation studies. The report is a continuation of previous annual reports on earthquake activity surrounding the eastern Snake River Plain (ESRP) and within and near the INL.

1.1 History of INL Seismic Monitoring Program

1.1.1 Purpose

The purpose of the INL Seismic Monitoring Program is to provide the INL with earthquake data and staff expertise in support of seismic safety for ongoing reactor operations and waste management activities, seismic and volcanic hazards assessments for new and existing buildings, and acquisition of new major programs. The INL Seismic Monitoring Program supports the requirements for safety of workers and the public set by Nuclear Regulatory Commission regulations, Executive Orders, and Department of Energy (DOE) Directives, Orders, and Standards. For example, the earthquake data are used to assess seismic hazards and develop seismic design criteria for the INL as required by DOE Order 420.1A “Facility Safety” (DOE, 2003).

The INL Seismic Monitoring Program operates 27 permanent seismic stations for the purpose of determining the time, location, and size of earthquakes occurring in the vicinity of the INL. The seismic data are compiled to develop an historical database that defines the zones and frequency of earthquake activity. Seismic stations are located within and around the INL near potential earthquake sources that include major range-bounding normal faults and volcanic rift zones (Figure 1).

The INL Seismic Monitoring Program operates 24 strong-motion accelerographs (SMAs) for the purpose of recording strong ground motions from local moderate or major earthquakes. The SMAs are located within INL buildings to determine the response of these buildings to ground motions in the event of a large earthquake. Several SMAs are located at “free-field” sites (not within buildings) at INL facility areas and are used to determine the levels of earthquake ground motions at the ground (rock or soil) surface. SMAs are also co-located with INL seismic stations to record acceleration data and assess attenuation effects of small to large magnitude normal faulting earthquakes.

1.1.2 Seismic Stations

The INL seismic network has evolved from a single analog station to its current configuration of 27 digital seismic stations. The INL Seismic Monitoring Program also records data from seismic stations owned and operated by other seismic networks. The INL seismic network began with a single station in 1971 and expanded to three stations by October of 1972. In 1977, the INL began monitoring a station operated by BYU-Idaho in Rexburg, Idaho, and the INL installed two additional stations in 1979. From

1979 to 1985, the INL monitored earthquake activity using six seismic stations. In 1985, the INL installed a simulated Wood-Anderson system to improve the capabilities of measuring the magnitude of local earthquakes ($3.0 \leq M_L \leq 5.0$). During 1986, the INL began receiving seismic data from a station located in Pocatello, Idaho and operated by the University of Utah in Salt Lake City, Utah. Also, in 1986, the INL began receiving data from a station located near Palisades Reservoir, Idaho that is operated by BYU-Idaho. A seismic station within the INL boundaries was added to the INL seismic network in 1987. During 1990, four more seismic stations were installed within the INL boundaries. During 1991-1992, thirteen new stations were installed in support of construction and operation of the proposed New Production Reactor at INL. Monitoring of BYU-Idaho seismic station near Palisades Reservoir was terminated in 1991 to accommodate the addition of the new INL seismic stations. In 1994, two new INL seismic stations were installed near Gray's Lake, Idaho. During 1999, the INL Howe Scarp (HWSI) seismic station was relocated further east to a new location now referred to as HWFI because of a lawsuit filed against the Bureau of Land Management (BLM). With the implementation of the EARTHWORM computer software in 2000, up to 14 stations from several nearby networks were being recorded in real-time along with the INL seismic stations. During 2001-2003, analog seismic instruments at all INL seismic stations were replaced with digital instruments. In 2003, the University of Utah transferred ownership of the Pocatello, Idaho (PTI) seismic station to the INL Seismic Monitoring Program at which time a digital seismic station was installed. With addition of the PTI station, INL currently operates 27 seismic stations.

1.1.3 Strong Motion Accelerographs

The INL began an accelerograph network by installing SMAs in buildings at INL facility areas, and more recently at free-field sites for both rock and soil conditions. In 1973, the INL began an accelerograph network by installing eleven SMAs in critical INL facilities. Three were located within buildings at the Idaho Nuclear Technology and Engineering Center (INTEC) (formerly referred to as Idaho Chemical Processing Plant - ICPP), two within the Materials and Fuels Complex (MFC) facilities (formerly referred to as Argonne National Laboratory – ANL), three within the Power Burst Facility (PBF), two within buildings at the Reactor Technology Complex (RTC) (formerly referred to as Test Reactor Area – TRA), and one at the Old Fire Station (OFS). From 1978 to 1979, four SMAs were installed at Test Area North (TAN) within the Containment Test facility (formerly referred to as Loss of Fluid Test – LOFT facility). Just prior to the October 1983 M_s 7.3 Borah Peak, Idaho earthquake, one SMA was installed at the INL Research Center (IRC), which is now part of the Science and Technology Complex (STC) in Idaho Falls, Idaho. Following the 1983 earthquake, two SMAs were installed within buildings at the Naval Reactor Facility (NRF). In 1984, two additional SMAs were placed within buildings at INTEC. During 1990, one SMA was installed at the Central Facilities Area (CFA). A digital SMA was co-located with an analog SMA at MFC in 1993. In 1996, two free-field SMA sites were installed, one at NRF and the other at PBF. In 1997, one SMA was installed as a free-field site at the Radioactive Waste Management Complex (RWMC). In 2003, the SMAs were upgraded to digital NetDAS SMAs. At that time, one NetDAS digital SMA replaced two SMAs co-located at Building ANL-767 (Kinemetrics analog SMA-1 and digital SSA-2 accelerograhs). The SMA on the crane beam at PBF-620 was not upgraded, but removed due to decommissioning activities.

Over the years, several SMAs have been relocated because buildings have been decommissioned and demolished. In 1995, the SMA at OFS was moved to a storage building directly behind the fire station because the fire station was decommissioned. In 1997 when the storage building was demolished, this SMA was relocated to the Experimental Field Station (EFS). In 1996, the Containment Test facilities or LOFT facilities were decommissioned. Three of the SMAs from LOFT were moved to the TAN Hot Shop and one was placed at the TAN Air Monitoring building. In 1997, the SMA at CFA was relocated to CFA-1607 Refueling Building. In 2004, the TAN Air Monitoring building was demolished so the SMA was removed and was reinstalled in 2005 as a free-field site at TAN. In 2004, the PBF building was demolished and the three SMAs were removed. The SMAs were reinstalled in 2005 as free-field sites near PBF and RWMC.

Three-component accelerometers were added to some of the seismic stations. In 2002, accelerometers were added to four seismic stations: Gray's Range (GRRI), New Production Reactor (NPRI), HWFI, and Bear Canyon (BCYI). In 2003, accelerometers were added to seismic stations Telchick Spring, Idaho (TCSI), Split Crater (SPCI), and PTI. During 2005, the INL Accelerograph Network operated 24 SMAs within or near INL Site facility areas and 7 three-component accelerometers at seismic stations.

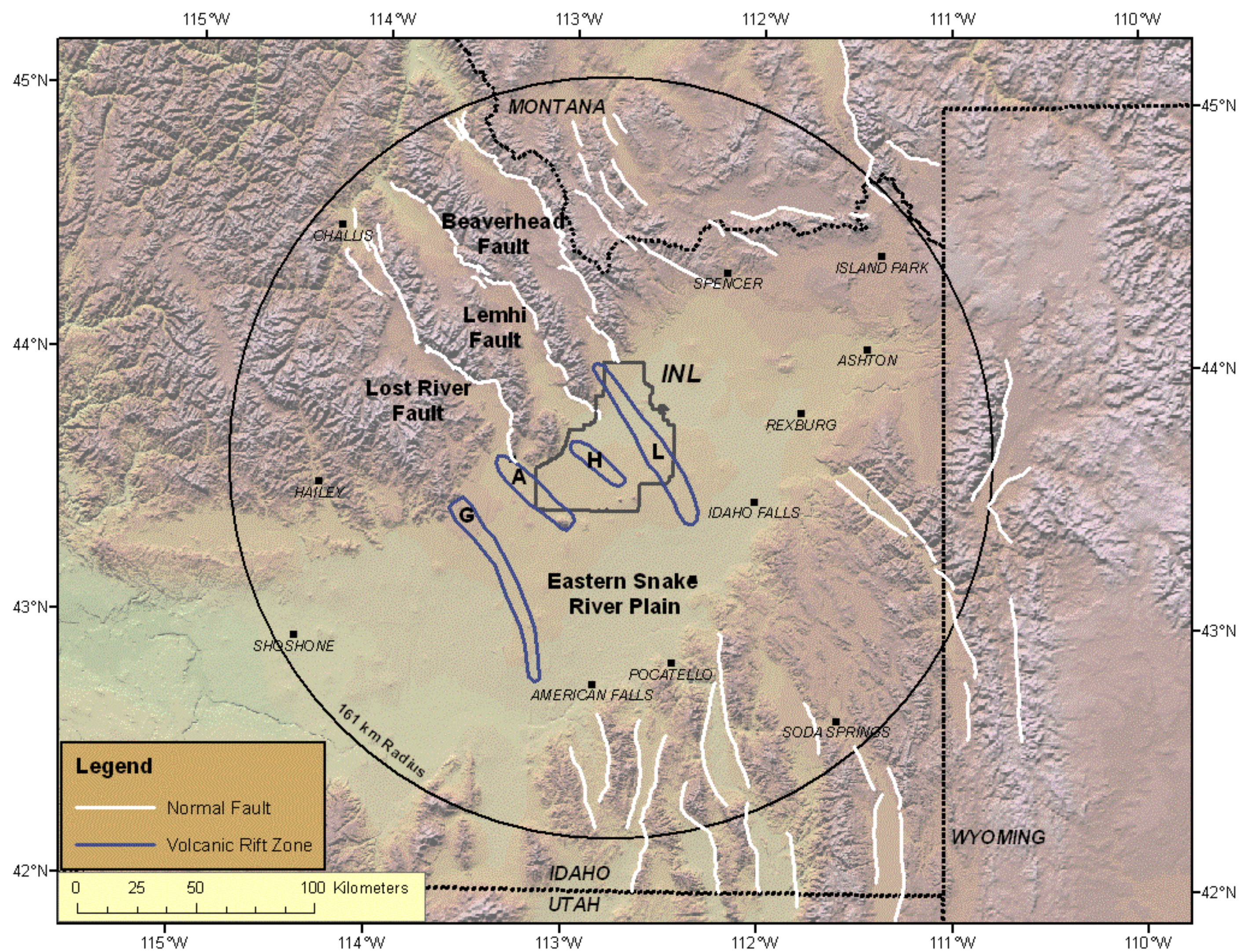

Figure 1. Map shows locations of the earthquake reporting area within the 161-km (100 mile) radius of the INL, Basin and Range normal faults, and volcanic rift zones: G – Great Rift, A – Arco, H – Howe-East Butte, and L – Lava Ridge-Hell's Half Acre.

2. Instrumentation

2.1 Seismic Station Network

During 2005, the INL Seismic Monitoring Program operated 27 permanent seismic stations and monitored 16 seismic stations from other nearby seismic networks (Figure 2). Table 1 lists the name, location, and date of installation for the seismic stations owned and operated by the INL Seismic Monitoring Program. Table 2 lists the name, location, and operation dates of seismic stations owned by other agencies. The INL records seismic data from these other seismic stations to improve the quality of earthquake locations within the 161-km radius of INL.

Instrumentation for INL seismic stations consists of digital recorders, one to three seismometers, and some accelerometers. The digital recorder is a DAQSystems NetDAS field unit, which is an embedded LINUX computer with a GPS clock and Symmetric Research 24 bit digitizer. The NetDAS units have nearly 22 bits of data resolution over ± 20 volts for a four-channel unit or ± 10 volts for an eight-channel unit. Four channel units (NetDAS-CH4) are located at seismic stations that have one or three sensors; eight channel units (NetDAS-CH8) are at seismic stations that have more than three sensors (such as three seismometers and three accelerometers). The seismic stations have pre-amplifiers that improve signal to noise ratios. The NetDAS digitizes data at the seismic station and time stamps the data with accuracies greater than 0.001 seconds. The seismic signals are transmitted by FreeWave Technologies DGR115 900 MHz Wireless Modem radios. These radios use standard IP (Internet Protocol) networking features that are included in the embedded LINUX.

Single-component seismic stations have vertically oriented velocity sensors that are a Mark Products model L-4C, Teledyne Geotech (TG) model S-13 or TG model S-13 Jr. seismometer buried within 3 m of the ground surface. All seismic stations located within the ESRP have a TG model S-13 J seismometer located at the bottom of 18 m or greater borehole to help dampen wind and cultural noise (Seismic, 1993). Seismic stations with horizontally oriented velocity sensors have two Teledyne Geotech model S-13 seismometers located within a concrete vault. Seismic stations with acceleration sensors have Applied MEMs Inc. model SF1500A, SF2500A, or SF3000L tri-axial accelerometers.

Seismic stations are powered by batteries, solar panels, and at some locations small wind generators where AC power is not available. Radio frequency compatible antennas transmit and receive the seismic signals. Several seismic stations are used as relay stations to allow transmission of seismic signals to the IRC in Idaho Falls. The seismic data are relayed by digital radios or Internet Digital Subscriber Line (DSL) links (Appendix A). The data are acquired through EARTHWORM data shares on the Internet (discussed in Section 2.5). Digital seismograms are continuously displayed on three of four computer monitors referred to as "Webicorders." The fourth monitor displays a map of current earthquakes located by the INL Seismic Monitoring Program.

2.2 Strong Motion Accelerographs

The INL accelerograph network has 24 strong-motion accelerographs at INL Site facilities; 23 are located at the INL Site and 1 is located in the IRC at the STC. Table 3 lists the location and date of installation for each of the SMAs in operation during 2005. There are 1 to 5 accelerographs at each INL Site facility area (Figure 3). Where possible, several SMAs are interconnected at a facility area so that if one instrument triggers to record data then others at that same area will also record data. Three SMAs are interconnected at TAN and two at INTEC. During 2005, earthquakes did not trigger an SMAs located within INL facilities. Some SMA free-field sites and accelerometers co-located with seismic stations recorded acceleration data for two earthquakes (see Section 4).

INL SMAs are DAQSystems NetDAS digital accelerographs that have Applied MEMS SiFlex SF2500 tri-axial accelerometers. Each SMA is set to trigger and record to compact flash when ground motions exceed 2500 counts, which is equivalent to about 0.005 g. The record lengths are set for 30 s of pre- and post-trigger thresholds. The triaxial accelerometers have two horizontal components oriented in an orthogonal manner, generally aligned in the north-south and east-west directions. Appendix B lists the accelerometer orientation and instrument response for the horizontal and vertical components of each SMA. SMAs at free-field sites have GPS clocks to synchronize the internal clocks to an absolute time system. For some SMAs at free-field sites and locations within buildings, acceleration data are transmitted to the IRC via digital radios or the Internet. Other SMAs record data on compact flash disks that are retrieved by INL seismic personnel using a laptop PC computer.

2.3 Continuous GPS Stations

The INL Seismic Monitoring Program has a geodetic network for the purpose of monitoring horizontal crustal deformation in support of INL seismic hazards assessments. GPS data are used to investigate active crustal deformation that is on the order of millimeters of movement per year within the ESRP, the surrounding Basin and Range, and Yellowstone Plateau. GPS data define regions of high velocity gradients having more frequent damaging earthquakes (e.g., Yellowstone – Hebgen Lake, Montana) than regions of low velocity gradients (e.g., eastern Snake River Plain). The spatial patterns of GPS data also constrain the fundamental geodynamic processes driving active continental deformation (e.g., Yellowstone hotspot). GPS data collected by INL also contribute to the larger scientific effort for the Plate Boundary Observatory operated under University NAVSTAR Consortium (UNAVCO) to understand western United States crustal deformation processes.

During 2005, six GPS receivers were co-located at INL seismic stations. Five GPS receivers are owned by the INL and one is owned by UNAVCO. There are three other continuous GPS stations owned by other agencies located within the 161-km radius of INL (Figure 4). Table 4 lists the name, ownership, location, and date of installation of the continuous GPS stations.

An INL GPS station consists of a Trimble NetRS GPS receiver connected to a L1/L2 dual frequency choke ring antenna. The antenna is attached to a 2.4 m steel rod that is drilled into a rock outcrop to a depth of about 1 m. Above ground the antenna is stabilized using a much larger PVC pipe filled with sand. This reduces the amount of wind noise within the GPS data, improving the accuracy. The NetRS receivers continuously collect GPS data. The data are relayed along with the seismic station data to DSL links, which are then accessed from the Internet at the IRC. Also, the data are downloaded daily from the Internet and archived by UNAVCO.

2.4 Seismic Data Acquisition and Analysis System

The INL records earthquake data on a computer Data Acquisition/Analysis System (DAAS) at the IRC. INL began recording earthquake data on the DAAS June 8, 1991 using the U. S. Geological Survey (USGS) CUSP processing software. Since 2001, significant upgrades have been made to the DAAS as a result of computer hardware and software advances. The USGS CUSP data acquisition and analysis software that supported use of the TIMIT program were replaced with the earthquake analysis program SEISAN (developed by the University of Bergen, Norway) in 2002 and the USGS EARTHWORM processing software in 2003. From June 1991 to November 2002, earthquake data were analyzed using the USGS TIMIT program. As of December 2002, earthquake data are now being analyzed using the SEISAN program. Use of the SEISAN and EARTHWORM programs facilitated the upgrades of seismic stations and SMAs to the NetDAS digital units, allowing concurrent waveform analyses of both velocity and acceleration data. Instrument responses of the NetDAS units at seismic stations and SMAs are now routinely performed and are integrated into the SEISAN database (see Appendices B and C). All digital earthquake data are also routinely archived to DVD media after analysis.

For acquisition of the earthquake data, the EARTHWORM program compares the digitized seismic data to the average noise or voltage level determined over a time interval of 1,000 s. The program determines that an earthquake has occurred when the amplitude of the voltage level over a 1-second time-interval for several stations within a subnet exceeds a threshold value of 2.5 times this average noise level. When an earthquake is detected, the seismograms for all stations within triggered subnets and the time codes are saved in a file on a disk. This file is labeled with a sequential number based on the date and time of the trigger for later reference to the earthquake in the SEISAN database. Each seismogram has 30 s of pre-event data and 20 s of post-event data stored within the file. In some instances, earthquakes have low-amplitude emergent P-waves with larger amplitude S-waves. When this occurs the DAAS may trigger on the S-waves instead of the P-waves, thus, saving 30 s of pre-event time allows recording of the P-waves also.

The earthquake detection software is set up to trigger on earthquakes detected by several stations within a subnet. Subnets contain several stations that are located in a small area and which are likely to detect the same local earthquake. All INL seismic stations usually detect earthquakes of magnitude 1.5. Since the INL stations cover a small area (as compared to the state of California, for example), the subnets were designed to reduce false triggers due to radio noise no longer an issue with digital communications. Subnets are specified for stations in close proximity to each other and their relationship to known seismic sources. For the ESRP though, a subnet was created for detection of small magnitude ($M < 0.5$) microearthquakes.

The EARTHWORM program also enables data sharing with other seismic networks in near real time over the Internet. The INL provides data from various seismic stations to the University of Utah, Montana Bureau of Mines and Geology, National Earthquake Information Center (NEIC), and BYU-Idaho, which in return provide data to INL (Table 2). EARTHWORM records seismic data from INL and these other agencies, which are analyzed using the SEISAN program.

Table 1. Seismic stations operated by INL.

Code	Station Name	Sensors Types	Latitude North (º)	Longitude West (º)	Elevation (m)	Date Installed (Month/Year)
ARNI	Argonne North, Idaho	Borehole Vertical Seismometer and GPS Reciever	43.6667	112.6235	1533	09/90
BCYI	Bear Canyon, Idaho	Vertical Seismometer, Three-component Accelerometers, and GPS Receiver	44.3108	113.4052	2194	05/92
CBTI	Cedar Butte, Idaho	Borehole Vertical Seismometer	43.3875	112.9115	1734	07/86
COMI	Craters of the Moon, Idaho	Vertical Seismometer	43.4618	113.5938	1890	03/92
CNCI	Crows Nest Canyon, Idaho	Vertical Seismometer	43.9283	113.4522	1914	05/92
CRBI	Circular Butte, Idaho	Borehole Vertical Seismometer	43.8303	112.6345	1520	11/87
ECRI	Eagle Creek, Idaho	Vertical Seismometer	43.0535	111.3705	2086	08/94
EMI	Eightmile Canyon, Idaho	Vertical Seismometer and GPS Receiver	44.0742	112.9262	1963	04/92
GBI	Big Grassy Butte, Idaho	Borehole Vertical Seismometer	43.9875	112.0633	1541	10/81
GRRI	Grays Range, Idaho	Vertical Seismometer and Three-component Accelerometers	42.9380	111.4217	2207	08/94
GTRI	Great Rift, Idaho	Borehole Vertical Seismometer and GPS Receiver	43.2440	113.2410	1522	05/92
HHAI	Hell's Half Acre, Idaho	Borehole Vertical Seismometer	43.2950	112.3795	1371	06/92
HPI	Howe Peak, Idaho	Vertical Seismometer and GPS Receiver	43.7113	113.0983	2597	10/72
HWFI	Howe Fault, Idaho	Three-component Seismometers and Accelerometers	43.9257	113.0973	1743	10/99

Table 1. Continued.

Code	Station Name	Sensors Types	Latitude North (º)	Longitude West (º)	Elevation (m)	Date Installed (Month/Year)
ICI	Italian Canyon, Idaho	Vertical Seismometer	44.3293	112.9412	2463	04/92
IRCI	INL Research Center, Idaho	Low-gain Three-component Seismometers	43.5153	112.0333	1442	11/88
JGI	Juniper Gulch, Idaho	Three-component Seismometers	44.0927	112.6768	1657	11/79
KBI	Kettle Butte, Idaho	Borehole Vertical Seismometer	43.5907	112.3767	1678	05/92
LJI	Lemhi Junction, Idaho	Vertical Seismometer	43.8208	112.8440	1643	05/90
LLRI	Little Lost River, Idaho	Three-component Seismometers and Accelerometers	43.7230	112.9330	1476	05/90
NPRI	New Production Reactor, Idaho	Three-component Seismometers and Accelerometers	43.5975	112.8272	1495	09/90
PZCI	Patelzick Creek, Idaho	Vertical Seismometer	44.3410	112.3172	2073	12/91
PTI	Pocatello, Idaho	Vertical Seismometer and Three-component Accelerometers	42.8703	112.3702	1670	10/84
SMBI	Sixmile Butte, Idaho	Borehole Vertical Seismometer	43.5022	113.2677	1716	05/92
SPCI	Split Crater, Idaho	Three-component Seismometers and Accelerometers	43.4500	112.6370	1553	06/92
TCSI	Telchick Spring, Idaho	Vertical Seismometer, Three-component Accelerometers, and GPS Receiver	43.6193	113.4783	1731	05/92
TMI	Taylor Mountain, Idaho	Three-component Seismometers	43.3057	111.9182	2179	10/72

Table 2. Stations monitored by the INL that are operated by other agencies.

Code	Station Name	Latitude North (º)	Longitude West (º)	Elevation (m)	Operating Dates (Month/Year)	
Brigham Young University – Idaho, Rexburg, Idaho						
CMI	Centennial Mountains, Idaho	44.6175	111.5165	2267	07/1980	Pres
IMW	Indian Meadows, Wyoming	43.8970	110.9392	2624	07/1980	Pres
RRI	Red Ridge, Idaho	43.3640	111.3190	2408	07/1985	Pres
U. S. National Seismic Network, Golden, Colorado						
AHID	Auburn, Idaho	42.7653	111.1003	1960	11/1997	Pres
BW06	Boulder, Wyoming	42.7667	109.5582	2224	05/1996	Pres
HLID	Hailey, Idaho	43.5625	114.4063	1498	08/1988	Pres
University of Utah, Salt Lake City, Utah						
BEI	Bear River Range, Idaho	42.1167	111.7823	1859	11/1984	Pres
BMUT	Black Mountain, Utah	41.9582	111.2342	2243	10/1979	Pres
MCID	Moose Creek, Idaho	44.1903	111.1827	2149	12/1995	Pres
MLI	Malad Range, Idaho	42.0268	112.1255	1896	10/1974	Pres
NPI	North Pocatello, Idaho	42.1473	112.5183	1640	04/1975	Pres
YMC	Maple Creek, Wyoming	44.7593	111.0062	2073	12/1983	Pres
YPP	Pitchstone Plateau, Wyoming	44.2710	110.8045	2707	08/1996	Pres
Montana Bureau of Mines and Geology, Butte, Montana						
MCMT	McKenzie Canyon, Montana	44.8277	112.8488	2323	09/1989	Pres
MOMT	Monida, Montana	44.5933	112.3943	2220	10/1995	Pres
TPMT	Teepee Creek, Montana	44.7298	111.6657	2518	10/1992	Pres

Table 3. Strong-motion accelerographs operated by INL.

INL Site Facility Area	Building Number	Location	SMA Code	Year Installed
MFC	ANL-767	Basement	EBR	1973
MFC	ANL-768	Basement	FCF	1973
CFA	CFA-1607	Free-field	CFAF	1996
CFA	EFS	Free-field	EFSF	1997
INTEC	CPP-668	Free-field	CPPF	1992
INTEC	CPP-601	First Floor	CPP1	1973
INTEC	CPP-601	Second Basement	CPP2	1973
INTEC	CPP-666	Second Floor	FAS1	1984
INTEC	CPP-666	Second Basement	FAS2	1984
NRF	NRF-768	Free-field	NRFF	1996
NRF	NRF-A1W	First Floor	A1W	1983
NRF	NRF-S1W	First Floor	S1W	1983
PBF	NA	Free-field	PBFF	2005
PBF	NA	Free-field	ARAF	2005
RTC	TRA-602	Free-field	TRAF	2003
RTC	TRA-642	Basement	TRA1	1973
RTC	TRA-670	Basement	TRA2	1996
RWMC	NA	Free-field	RWMC	1997
RWMC	NA	Free-field	RWME	2005
STC	IRC-602	First Floor	IRC	1983
TAN	NA	Free-field	TANA	2005
TAN	TAN-607	First Floor	TAN1	1996
TAN	TAN-607	Second Floor	TAN2	1996
TAN	TAN-607	Third Floor	TAN3	1996

NA – Not within a building.

Table 4. Location and ownership of continuous recording GPS stations.

Code	Station Name	Latitude North (º)	Longitude West (º)	Elevation (m)	Year Installed
Idaho National Laboratory					
ARNG	Argonne North, Idaho	43.6667	112.6235	1533	2005
BCYI	Bear Canyon, Idaho	44.3108	113.4052	2194	2003
EMIG	Eightmile Canyon, Idaho	44.0742	112.9262	1963	2005
HPIG	Howe Peak, Idaho	43.7113	113.0983	2597	2005
TCSG	Telchick Spring, Idaho	43.6193	113.4783	1731	2005
Yellowstone Hotspot GPS Network (UNAVCO)					
GTRG	Great Rift, Idaho	43.2440	113.2410	1522	1998
BBID	Big Bend Ridge, Idaho	44.1851	111.5261	1811	2001
AHID	Auburn, Idaho	42.7731	111.0637	1975	2000
HLID	Hailey, Idaho	43.5626	114.4144	1774	1999

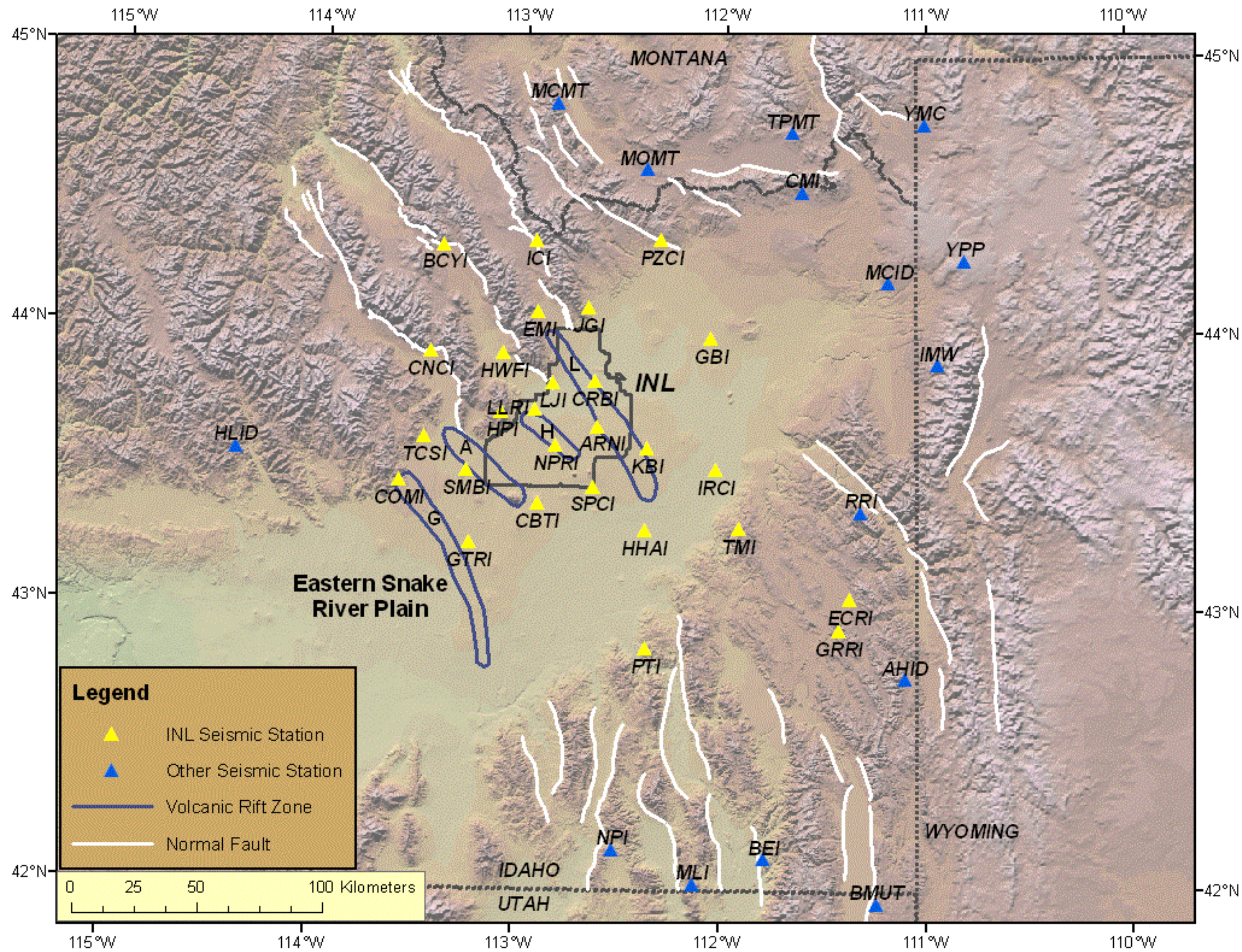

Figure 2. Locations of INL seismic stations and stations monitored by INL that are operated by other institutions. See Figure 1 for names of normal faults and volcanic rift zones.

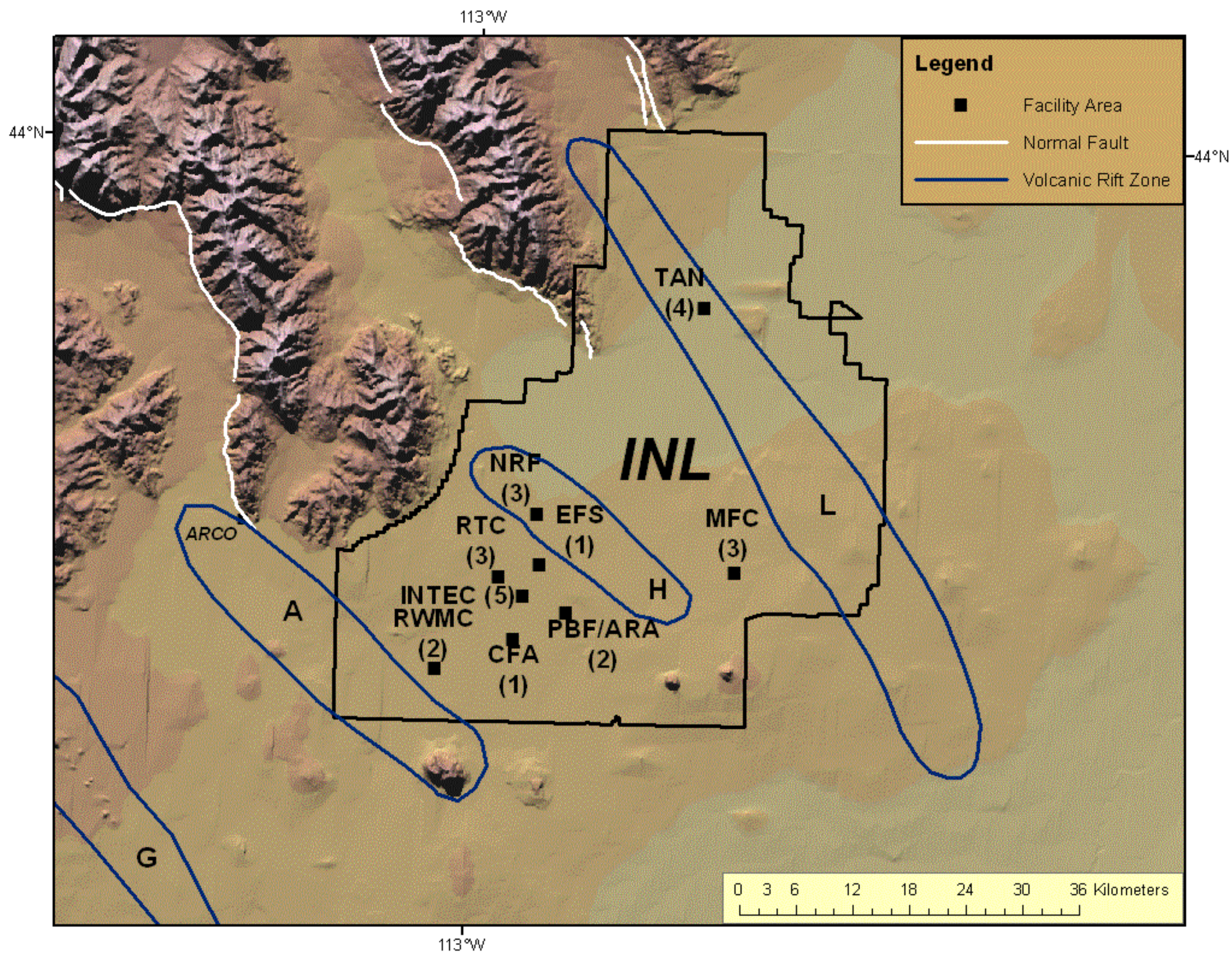

Figure 3. Numbers (in parentheses) of SMAs located at INL facility areas. See Figure 1 for names of normal faults and volcanic rift zones.

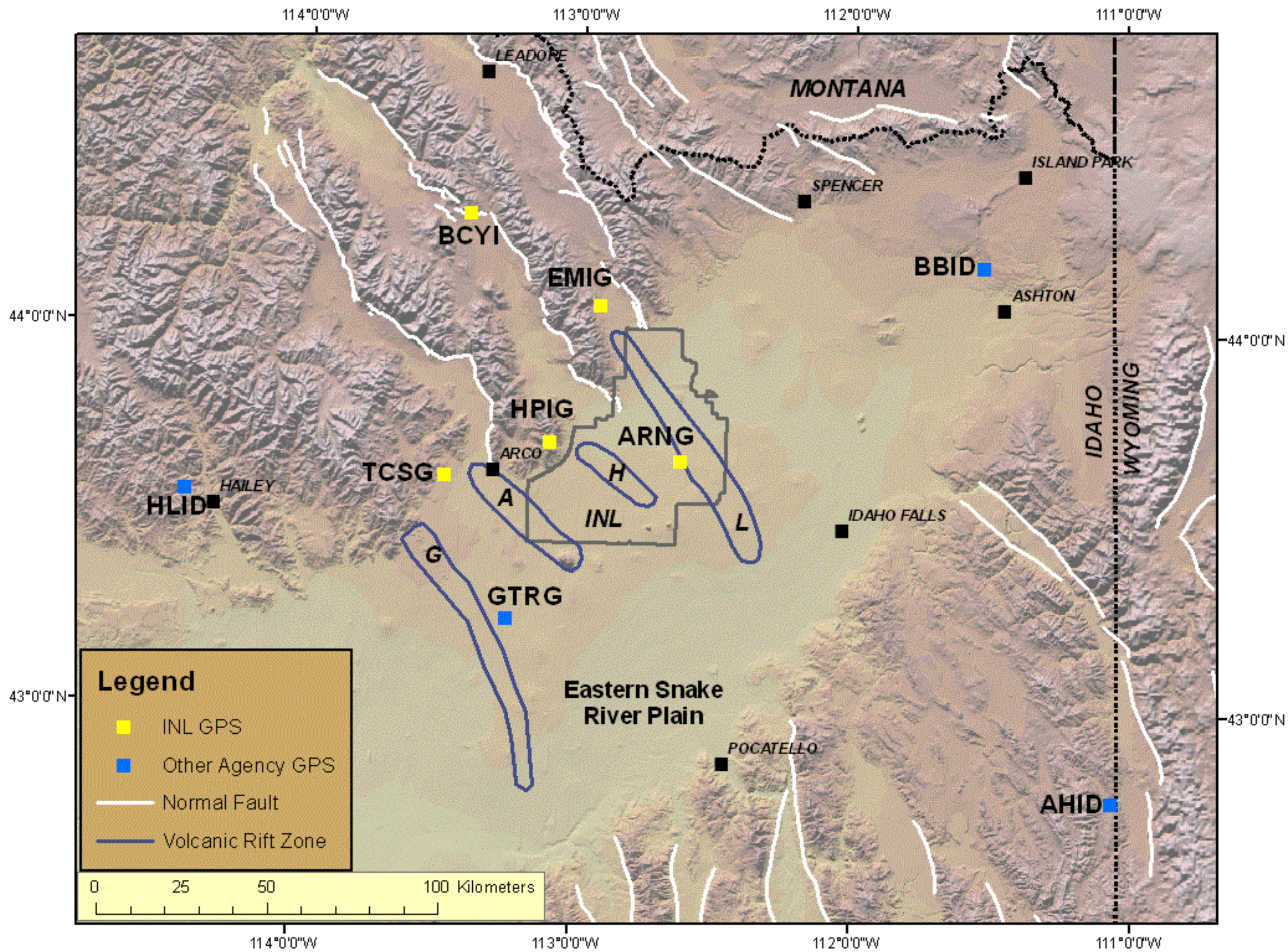

Figure 4. Locations of the continuous GPS stations co-located at INL seismic stations and operated by other agencies. See Figure 1 for names of normal faults and volcanic rift zones.

3. Data Analysis

Digital seismograms are analyzed using the SEISAN program to determine the location, magnitude, and peak ground accelerations. SEISAN displays multiple seismograms on a computer screen with corresponding times codes having accuracy to ± 0.001 s. P- and S- wave arrival times of the seismograms are selected to ± 0.01 s. Either duration or amplitude of a seismic signal is selected and then used to calculate the magnitude of an earthquake. The arrival times, durations, and amplitudes measured for an earthquake are saved in a computer file directly from the SEISAN program. A separate program then calculates the location and magnitude of an earthquake. The locations and magnitudes of the earthquakes are plotted on maps to assess seismically active regions near the INL. Amplitudes of the accelerograms are also measured using the SEISAN program, then processed using a separate program that outputs peak horizontal and vertical accelerations.

3.1 Location Method

The HYPOINVERSE computer program (Klein, 1989) is used to determine locations for all local earthquakes recorded. Phase data files (arrival times of the earthquake) from the output of SEISAN are input into the HYPOINVERSE location program. At a minimum, four P-wave and two S-wave arrival times (six total) are used to determine the location of an event. According to Zollweg and Sprenke (1995), stable locations are usually obtained from about seven to ten arrival times for recorded events that are not surrounded by INL seismic stations. Within the INL network, stable locations can be obtained with a minimum of six arrival times. Because of the density and sensitivity of the INL seismic network, the majority (usually more than 95%) of earthquakes located within the 161-km radius have a minimum of seven arrival times. Seismic stations from other agencies monitored by the INL provide coverage outside the INL network and phase arrivals from these stations supplement phase data from INL stations.

Six P-wave velocity models are used in the HYPOINVERSE location program depending on the location of the earthquakes (Table 5). The “ESRP” velocity model is used for locating earthquakes that occur within the ESRP including the mountainous terrain on the northern and eastern edge of the Plain (Olsen et al., 1979; Sparlin et al., 1979; Braile and Smith, 1979; and Ackerman, 1979). The “INL ESRP” velocity model is used to locate earthquakes that occur on the ESRP and are near or within the INL Site boundaries. This model was developed from Sparlin et al. (1982) and Braile et al. (1982) and checked with respect to a few microearthquakes located within the ESRP (Jackson et al., 1989). The “BPEAK” velocity model is used for locating earthquakes that occur in the Borah Peak aftershock area and the mountainous terrain northwest of the Plain (Richins et al., 1987). The “PAL BFR” velocity model is used to locate earthquakes that occur near the Palisades and Blackfoot River reservoirs (Wood, 1988). The “SMT” velocity model is used to locate earthquake in southwestern Montana (Stickney, 1997). Finally, the “UTAH” velocity model is used to locate earthquakes that occur near the Idaho-Utah border (Nava et al., 1990). For all velocity models, a P-wave velocity to S-wave velocity ratio of 1.75 is used (Bones, 1978; Greensfelder and Kovach, 1982; and Richins et al., 1987).

Other parameters used in the HYPOINVERSE location program are the starting focal depth, distance weighting, and cut off for the root mean square of the timing residuals. These parameters are set as follows:

- Starting focal depth is 5 km
- Distance cut off for weighting is 50 km
- Root mean square of timing residuals is 0.16 sec

Zollweg and Sprenke (1995) evaluated the parameters chosen for the HYPOINVERSE program used by INL. They determined that the parameters chosen yield good location results despite the poor coverage in azimuth of earthquakes outside the network. An evaluation of the difference between the observed and computed latitude and longitude was less than 0.25 km.

3.2 Magnitude Calculations

Magnitudes are determined using two methods 1) coda magnitudes using signal duration of digital seismograms and 2) local magnitudes using amplitudes from digital seismograms. Coda magnitudes (M_c) are calculated for earthquakes of magnitudes less than 3.0 using signal durations of several earthquakes recorded on different seismic stations. Local magnitudes (M_L) are calculated using the largest peak-to-peak trace amplitude measured from digital waveforms and the Richter magnitude equation. If a magnitude cannot be determined for a local earthquake, then magnitudes determined by other seismic networks may be used. These include the University of Utah, Montana Bureau of Mines and Geology, NEIC, Boise State University, and the U.S. Bureau of Reclamation.

The following expression is used to calculate coda magnitudes for the signal duration method (Arabasz et al., 1979):

$$M_c = -3.13 + 2.74 \log \tau + 0.0012 \Delta \qquad [1]$$

Where:

τ = Total signal duration in seconds;

Δ = Epicentral distance from each station in km.

The duration is measured at the start of the earthquake signature (P-wave arrival) to the end of the coda, where the signal fades into the background noise of the trace. The final magnitude is determined by averaging the coda magnitude calculated for each seismogram. The SEISAN program automatically selects the duration of the earthquake when the P-wave arrival time is selected. Equation (1) is usually used to estimate magnitudes for events located by the HYPOINVERSE location program.

Local magnitudes calculated from the digital seismograms are based on the Richter magnitude scale. Richter (1958) defined the local magnitude scale from the following equation:

$$M_L = \text{Log } A - \text{Log } A_o \qquad [2]$$

Where:

A = Recorded maximum trace amplitude from the zero-line measured in millimeters on a standard seismogram;

A_o = Maximum trace amplitude from the zero-line in millimeters for a selected standard earthquake.

Dr. Richter developed the scale for a standard earthquake of magnitude 3.0 at 100 km for A_o = 0.001 mm and amplitude of 1.0 mm measured on the standard seismogram. He constructed a table of magnitudes based on distance and -Log A_o for maximum trace amplitudes recorded on the standard Wood-Anderson seismogram.

SEISAN has a program that uses equation [2] with amplitudes measured on a synthetic Wood-Anderson digital seismogram. The program allows the user to select the option to convert a horizontal time history for an accelerometer or seismometer of an INL seismic station to a synthetic Wood-Anderson seismogram. The SEISAN program uses the instrument response information contained in Appendix B for accelerograms and Appendix C for seismograms to calculate synthetic Wood-Anderson seismograms at a magnification of 2800. The user then selects the largest peak-to-peak amplitude (or A) in millimeters from the digital display of the synthetic Wood-Anderson seismogram. The SEISAN program then uses the distance of the simulated Wood-Anderson station to the earthquake's epicenter and ½ the peak-to-peak amplitude to determine local magnitude using Richter's table. The program determines the local magnitude for each of the amplitudes selected. The program calculates a median magnitude for the earthquake.

3.3 Peak Accelerations

Peak horizontal and vertical accelerations are determined for accelerograms using the SEISAN program (Section 2.4). SEISAN displays the horizontal and vertical accelerograms for some free-field SMAs located at the INL and accelerometers co-located with the seismic stations. The SEISAN program allows the user to correct the accelerograms by removing the instrument responses listed in Appendices A and B. A separate program is used to measure the largest zero-to-peak acceleration amplitude from the corrected acceleration time history.

3.4 Location Quality

Comparisons between earthquake locations determined by the INL and locations determined by other temporary networks or NEIC have been used to approximate locations errors of earthquake epicenters (Jackson et al., 1993a). This method was very general and yielded an approximation of the quality of the INL earthquake locations. In 1995, the State of Idaho requested Zollweg and Sprenke (1995) to perform an independent assessment of the INL Seismic Monitoring Program. Zollweg and Sprenke (1995) evaluated the location accuracy of the INL seismic network by two methods: 1) directly comparing INL locations to well-located earthquakes; and 2) indirectly by evaluating the network bias or non-random error through varying independent permutations (or combinations) of recording stations.

For the first method, twenty-two earthquakes having high-quality locations determined from a temporary seismic network installed near Challis, Idaho from July 1, 1992 to July 12, 1992 (by Boise State University) were compared to INL locations for these earthquakes. The earthquakes were located about 120 km from the center of INL, had varying magnitudes ranging from 1.9 to 4.5, and had absolute errors less than 1 km. The epicenters determined by INL seismic stations for these events differed by 1.6 to 11.5 km with an average of 7.1 km. The differences in locations were dependent on magnitude, with the smaller magnitude earthquakes tending to have greater differences in locations (Zollweg and Sprenke, 1995). These results are similar to the earlier estimates of an error radius of 5 km for a comparison to high-quality locations of the aftershocks from the M_s 7.3 October 28, 1983 earthquake (Jackson et al., 1993a). However it is noted that this estimate for an error radius was based on having five stations in the INL seismic network at that time. The closest station to the aftershocks was at a distance of 50 km or more.

The second method used by Zollweg and Sprenke (1995) evaluates the network bias. Unless all earthquakes are located using exactly the same groups of stations and phases (P- and S-waves), the relative locations will be affected by a non-random error or network bias. The network bias is important for the smaller earthquakes that make up the majority of the events in a catalog since fewer stations usually record smaller earthquakes. Five earthquakes located northwest of the INL seismic network and ranging in magnitude from 1.8 to 3.8 were used in the analysis. Because INL operated 26 seismic stations at the time of the assessment, there were millions of possible combinations of recording stations. Zollweg and Sprenke (1995) chose to vary the combination of the ten most influential phase arrivals for the permutation analysis. The locations for most of the permutations clustered about radii ranging from 6.5 to 11 km. For the magnitude 3.8 earthquake, 8% of the permutations resulted in a linear band extending 100 km. Zollweg and Sprenke (1995) suggested that earthquakes located with fewer S-wave arrival times have less well-constrained locations. Some of the larger earthquakes, like the magnitude 3.8 earthquake, have fewer S-wave arrival times because the signals saturate the instrumentation and onset of the S- wave is indistinguishable from the P-waves. Earthquakes with more than three S-wave-arrival times resulted in better-constrained locations.

3.5 Depth Quality

The HYPOINVERSE location program also calculates depth to the hypocenter. Focal depths calculated by this program are not accurate for many of the earthquakes recorded by the INL seismic network for two reasons: 1) the station spacing is usually greater than twice the focal depth of the earthquake recorded; and 2) the earthquake usually occurs outside of the network. To calculate accurate focal depths, the earthquake must occur within the seismic network and at a distance equal to or less than its focal depth. Although focal depths are listed in Appendix D, they should be interpreted within the context of the limitations discussed in this section unless otherwise indicated.

3.6 Data Completeness

Local earthquakes are easily discriminated from other seismic data such as local mine blasts, air blasts (or sonic booms), and distant (worldwide) and regional earthquakes occurring far outside of the INL seismic network. For example, man-made blasts are easily discriminated from earthquakes on the basis of P- and S- wave arrival time patterns, the time the event occurred, and the location of the event. Confirmation of distant and regional earthquakes are routinely made using the NEIC website.

Detection threshold can provide a measure of completeness for the INL earthquake catalog. It is defined as the magnitude level at which the seismic network will nearly always locate an earthquake. Zollweg and Sprenke (1995) evaluated the detection threshold by plotting the cumulative number of earthquakes as a function of magnitude to determine the lowest magnitude point that the curve begins to flatten. Zollweg and Sprenke (1995) determined the detection threshold to be a magnitude 1.3 anywhere within a 100-mile radius around INL. Their conclusion was based on a plot of 1360 earthquakes for an 18-month period. Since the seismic stations are all located within 90 km of the center of INL, they suggested that the detection threshold is magnitude 0.8 within the network on the ESRP. The analysis of Zollweg and Sprenke (1995) suggests that the INL earthquake catalog is complete for magnitudes above 1.3 within a 100-mile radius of INL and may be complete for magnitudes as low as 0.8 within the network. Hardware and software upgrades for the current DAAS have increased detection sensitivities on the order of magnitude 0.0 which allow recording of small magnitude microearthquakes within ESRP.

Table 5. P-wave velocity models used in location programs.

Velocity Model Code	Velocity (km/sec)	Depth to Top of Layer (km)	Layer Thickness (km)	References
ESRP	4.90	0.00	2.00	Olsen et al., 1979; Sparlin et al., 1979; Braile & Smith, 1979; Ackerman, 1979.
	6.00	2.00	15.00	
	6.70	17.00	23.00	
	7.90	40.00	Half-space	
INL ESRP	3.30	0.00	1.00	Sparlin et al., 1982; Braile et al., 1982; Jackson et al., 1989.
	4.90	1.00	2.00	
	5.30	3.00	2.00	
	6.15	5.00	2.00	
	6.53	7.00	10.00	
	6.80	17.00	23.00	
	8.00	40.00	Half-space	
BPEAK	4.75	0.00	1.64	Richins et al., 1987.
	5.59	1.64	5.31	
	6.16	6.95	11.05	
	6.80	18.00	22.00	
	8.00	40.00	Half-space	
PAL BFR	4.80	0.00	2.00	Wood, 1988.
	5.45	2.00	3.90	
	6.14	5.90	2.50	
	6.32	8.40	6.10	
	6.56	14.50	25.20	
	8.00	40.00	Half-space	
SMT	5.52	0.00	5.86	Stickney, 1997.
	6.12	5.86	12.78	
	6.74	18.64	20.05	
	8.00	38.69	Half-space	
UTAH	3.40	0.00	1.40	Nava et al., 1990.
	5.90	1.40	14.10	
	6.40	15.50	9.90	
	7.50	25.40	16.60	
	7.90	42.00	Half-space	

4. 2005 Earthquake Activity

During 2005, INL recorded 2390 independent triggers from earthquakes both within the region and from around the world. Thirty-one small to moderate size earthquakes ranging in magnitude from 3.0 to 5.7 occurred outside the 161-km radius. The earthquake activity occurred in areas that included Cascade Reservoir, Idaho; Challis, Idaho, the southwestern Montana-Idaho border, Dillon Montana, Yellowstone National Park, Wyoming, Jackson, Wyoming, and northern Utah. 449 earthquakes were located within the 161-km (or 100-mile) radius of INL (Appendix C). Seven earthquakes exceeded M_L 3.0, the largest earthquake had a M_L of 4.6. The earthquakes were located in areas that have been seismically active in the past, along the basin and range faults northwest of INL, southwestern Montana, and southeastern Idaho.

4.1 Regional Earthquake Activity

Thirty-one earthquakes of magnitudes from 3.0 to 5.7 occurred outside the 161 km radius of INL (Figure 5). Of these earthquakes, twenty-three were associated with the body wave magnitude (m_b) 5.7 Dillon, Montana earthquake and its aftershocks. The remaining eight earthquakes occurred in areas surrounding the ESRP. An earthquake M_L 3.3 occurred on July 23, 2005 in northern Utah. Two earthquakes of M_L 3.0 (on February 3, 2005 and July 27, 2005) occurred northeast of Jackson, Wyoming. An earthquake of M_L 3.6 occurred on March 18, 2005 in southwestern Montana southeast of Dillon. Two earthquakes of M_L 3.0 (September 3, 2005) and 3.7 (November 25, 2005) occurred in central Idaho west of Leadore, Idaho. One earthquake of M_L 3.3 occurred near Stanley, Idaho on April 6, 2005.

An intense earthquake swarm (over 1,000 earthquakes) began on September 21, 2005 and continued through November 2005. The swarm was located 88-96 km north of Boise, Idaho just south of Cascade Reservoir. Local residents felt many of the earthquakes. INL recorded several earthquakes of the magnitude 3.0 and greater, including the largest earthquake of M_L 3.9 that occurred on September 29, 2005 (plotted on Figure 5).

INL recorded the July 26, 2005 m_b 5.7 Dillon, Montana earthquake and 100's of associated aftershocks. INL measured a M_L 5.8 at the seismic station SPCI for the main shock, slightly higher than the m_b measured by NEIC. The main shock was located more than 170 km (105 miles) from INL facilities and was not reported felt (Figure 5). The main shock did not trigger any SMAs located within INL buildings. Free-field SMAs and accelerometers co-located with seismic stations recorded acceleration data. Peak horizontal and vertical accelerations range from 0.0077 to 0.0006 g (Table 6).

4.2 Local Earthquake Activity

There were 449 earthquakes within the 161-km radius of INL that occurred in the Basin and Range Province surrounding the ESRP. No earthquakes occurred within the INL boundaries or the ESRP. Seven of the earthquakes within 161-km radius of INL exceeded magnitude 3.0. The largest earthquake had a moment magnitude (M_w) 4.6 occurred on October 31, 2005 and was located north of Leadore, Idaho. The earthquake had an epicenter 100 km (62 miles) from INL. The earthquake did not trigger SMAs within INL facilities. Free-field SMAs and accelerometers co-located at seismic stations recorded peak horizontal and vertical accelerations that range from 0.0003 to 0.0030 g (Table 7).

Three earthquakes of M_L 3.0 (January 29, 2005), 3.0 (February 4, 2005), and 3.1 (March 31, 2005) occurred near the northern end of the Lost River fault just south of Challis, Idaho (Figure 5). Earthquakes of smaller magnitudes occurred south of Challis and east of Stanley throughout the year, but increased activity occurred from January to March during the times of the magnitude 3 earthquakes (Figure 6). An earthquake of M_L 3.2 occurred north of Spencer, Idaho on June 29, 2005. This earthquake occurred in southwestern Montana, which was active throughout 2005 (Figure 6). Two earthquakes of M_L 3.1 and 3.7 occurred on November 21, 2005 and were located north of Island Park, Idaho along the border of the 161 km radius of INL (Figure 5). For the remainder of November increased earthquake activity occurred near the location of the two magnitude 3 earthquakes, just within the 161 km radius of INL (Figure 6).

Throughout 2005, the basin and range region southeast of the ESRP along the Idaho-Wyoming border experienced earthquake activity. The earthquakes had magnitudes less than 3.0. From April to May, a swarm of earthquakes (>60 earthquakes) occurred southeast of Ashton, Idaho (Figure 6).

5. 1972 – 2005 Earthquake Activity

Since earthquake monitoring began at INL in 1972, only small magnitude microearthquakes of $M_L \leq 1.5$ have occurred within the ESRP. Figure 7 shows that the earthquakes in 2005 occurred in areas within and around the ESRP that have been active in the past. Even though microearthquakes ($M_L \leq 1.5$) have occurred within the ESRP, earthquake monitoring by the INL seismic network for the last 33 years indicates that the ESRP has been seismically inactive relative to the surrounding Basin and Range Province (Jackson et al., 1993b).

Table 6. Peak accelerations recorded for the July 26, 2005 (04:08 UTC) m_b 5.7 Dillon, Montana earthquake.

Station Code	Distance From Earthquake Epicenter (km)	Peak Acceleration (g) for Tri-axial Components		
		North	East	Vertical
BCYI	141	0.0077	0.0051	0.0032
HWFI	174	0.0033	0.0021	0.0043
TANA	178	0.0044	0.0038	0.0017
NPRI	207	0.0011	0.0022	0.0006
PBFF	211	0.0015	0.0018	NR
RWMC	218	0.0016	0.0016	0.0012
RWME	220	0.0020	0.0028	0.0009

NR – Not recorded.

Table 7. Peak accelerations recorded for the October 31, 2005 (00:23 UTC) M_w 4.6 Leadore, Idaho earthquake.

Station Code	Distance From Earthquake Epicenter (km)	Peak Acceleration (g) for Tri-axial Components		
		North	East	Vertical
BCYI	61	0.0030	0.0024	0.0018
NRFF	140	0.0004	0.0005	0.0003
TRAF	146	0.0014	0.0012	0.0007
NPRI	148	0.0006	0.0005	0.0005
PBFF	151	0.0007	0.0010	0.0005
RWMC	153	0.0006	0.0005	0.0004
RWME	155	0.0007	0.0009	0.0005
SPCI	169	0.0009	0.0008	0.0009

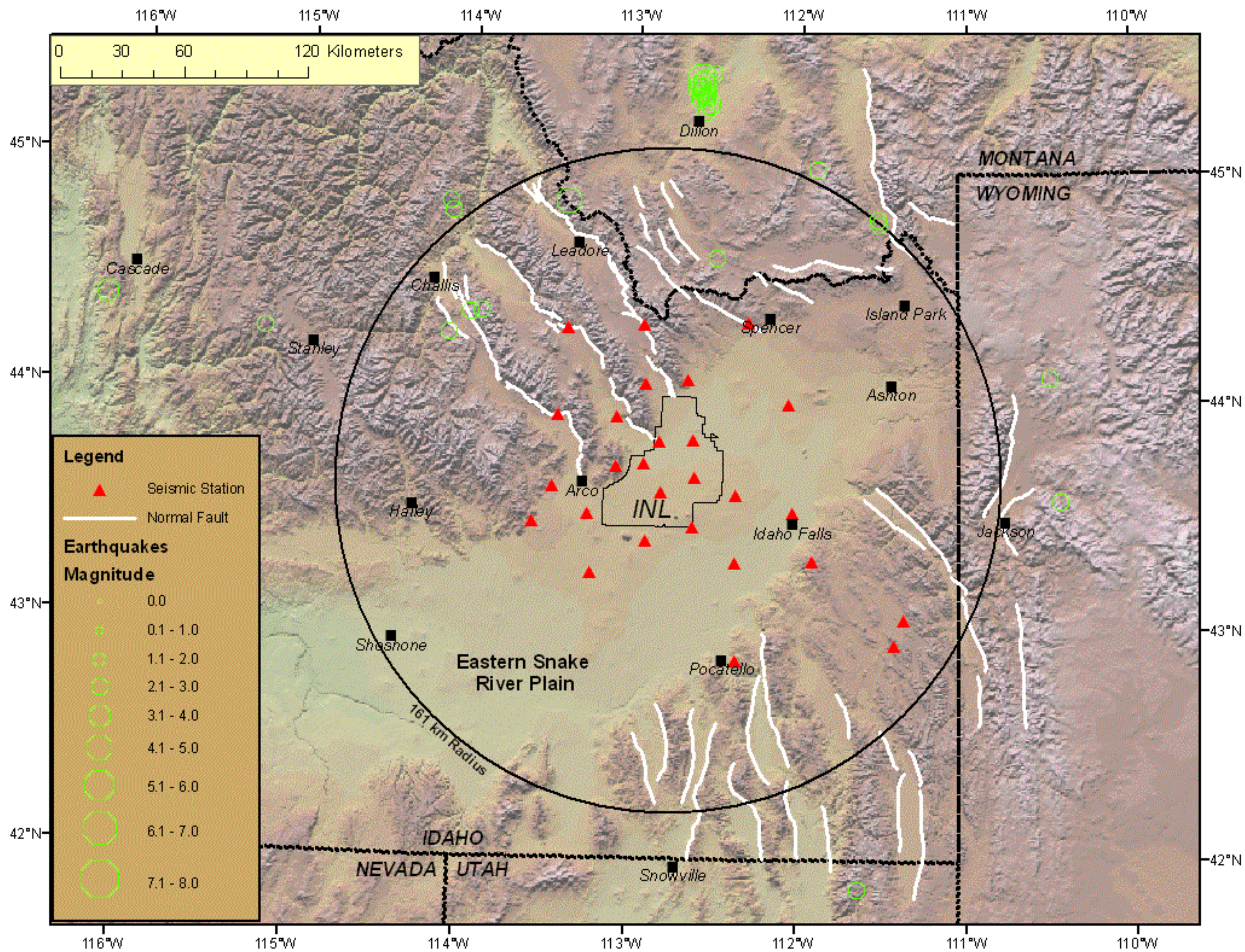

Figure 5. Map shows epicenters of earthquakes for magnitudes greater than 3.0 during 2005.

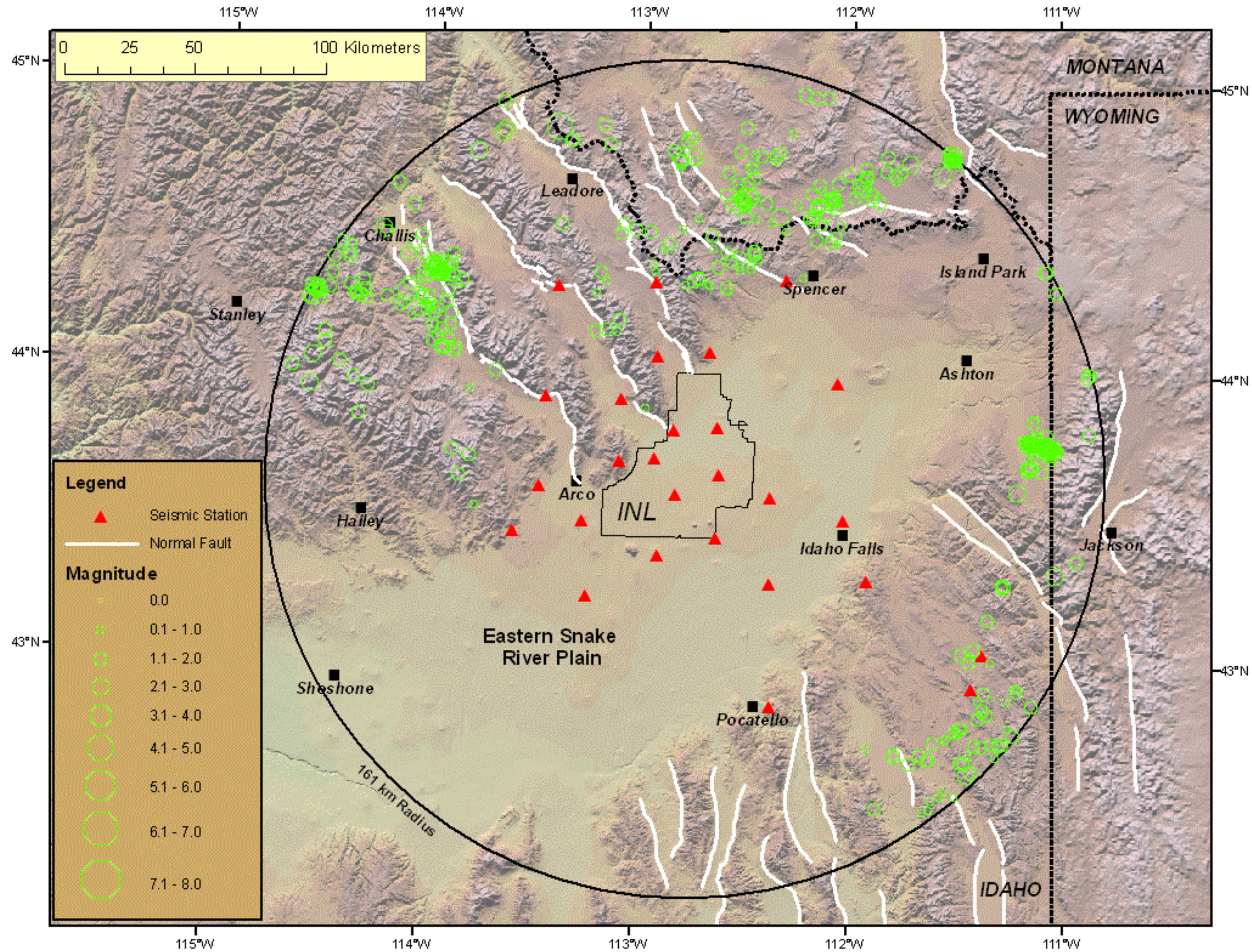

Figure 6. Map shows epicenters of earthquakes within the 161-km radius of INL from January 1, 2005 to December 31, 2005.

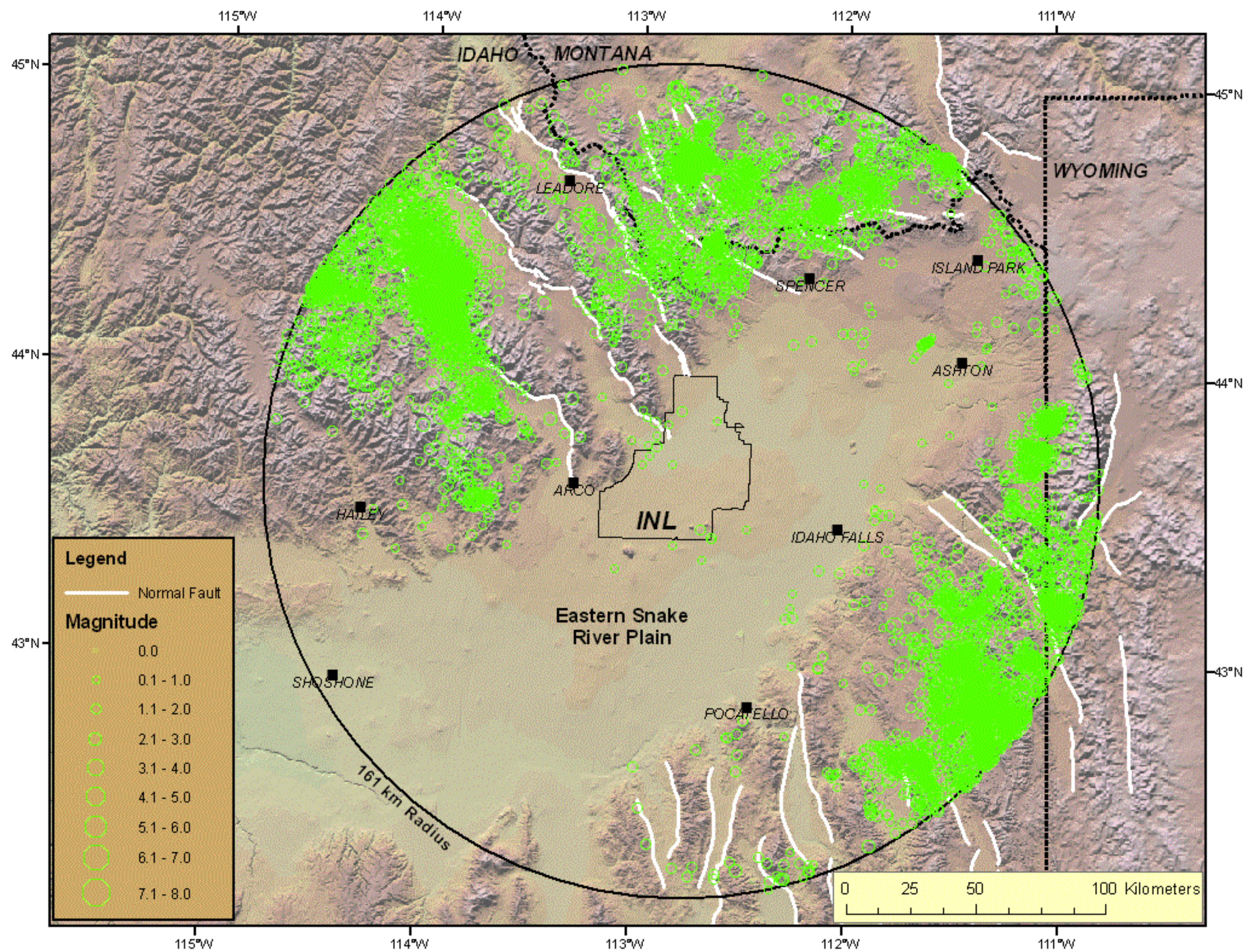

Figure 7. Map shows epicenters of earthquakes from 1972 to 2005 within the 161-km radius of INL.

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Appendix A

Seismic Station Telemetry

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Appendix A

Seismic Network Telemetry

Digital radios, Internet, or DSL links transmit seismic data from INL seismic stations and free-field SMAs to the IRC. Some seismic stations are used as relay links to transmit several seismic stations to a DSL drop point or directly to the IRC. Figure A-1 shows the telemetry configuration during 2005.

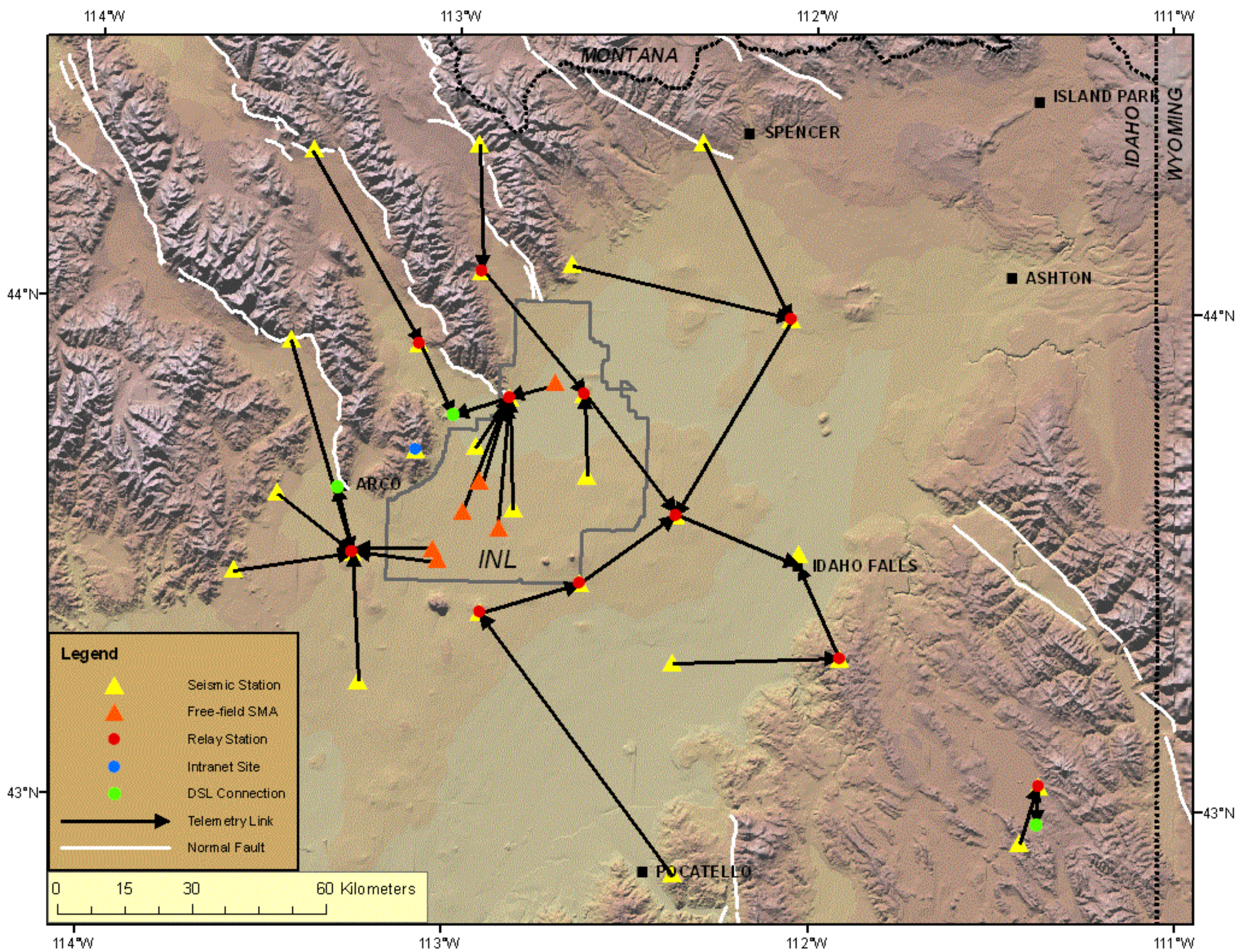

Figure A-1. Telemetry configuration of INL seismic stations and free-field SMAs during 2005.

Appendix B

Instrument Response of NetDAS SMAs

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Appendix B

Instrument Response of NetDAS SMAs

B.1 Method for Determining Amplitude Response

The instrument response of the NetDAS-SMA is used to convert the measured counts of ground motion amplitude to units of g. The NetDAS units that have accelerometers mounted within the unit are calibrated by conducting 1-g (acceleration of gravity) tilt tests. These tests are done on a leveled pad at the IRC seismic lab or on the actual leveled pad at their physical location listed in Table 3. These 1-g tilt tests provide a relationship of the number of digitizer counts equivalent to 1-g offset. From this relationship, the number of counts per g is established. Equation B-1 provides the conversion from the measured count level to actual g level for the recorded motion. Trigger threshold accelerations and counts/g are listed for NetDAS units with SMAs in Table B-1 using equation:

$$\text{Equivalent acceleration (g)} = \text{Counts}_{\text{(Measured or target)}} / \text{(counts/g)} \qquad \text{[B-1]}$$

Equation B-1 cannot be used to convert waveform data collected by the NetDAS units without accelerometers installed in them. For a NetDAS unit without accelerometers there is a frequency dependent amplitude response, which is discussed further in Appendix C. The frequency response information for the NetDAS-4CH should be applied to the acceleration data recorded by accelerometers external to these units. Table B-2 lists the instrument response for these accelerometers using the methods discussed in Appendix C.

Tables B-1 and B-2 list the beginning and ending dates for the time periods that the instrument responses are applicable. If changes occurred to SMA or seismic station instrumentation (such as accelerometer or NetDAS unit) during the year, then more than one range of dates are listed for a location. Also, note that the building numbers and locations for the SMA codes are listed in Table 3.

Table B-1. Instrument response for strong-motion accelerographs.

		Instrument Response			Accelerometer				
INL Site Facility Area	SMA Code	Begin Date	End Date	NetDAS Serial #	Model	Orientation	Positive Direction	Counts/g	Trigger Level (g)
CFA	CFAF	5/6/2004	12/31/2005	1097	SF2500A	Vertical	Down	547045	0.0046
						North	0	551038	0.0045
						East	270	558177	0.0045
	EFSF	5/6/2004	12/31/2005	1096	SF2500A	Vertical	Down	553390	0.0045
						North	0	526189	0.0048
						East	270	549747	0.0045
INTEC	CPPF	5/20/2004	12/31/2005	2000	SF2500A	Vertical	Down	552940	0.0045
						North	0	569846	0.0044
						East	270	557651	0.0045
	CPP1	5/19/2004	12/31/2005	1099	SF2500A	Vertical	Down	522025	0.0048
						North	0	563402	0.0044
						East	270	569090	0.0044
	CPP2	5/19/2004	12/31/2005	1078	SF2500A	Vertical	Down	615499	0.0041
						North	0	647203	0.0039
						East	270	628378	0.0040
	FAS1	5/19/2004	12/31/2005	1084	SF2500A	Vertical	Down	568601	0.0044
						North	0	572126	0.0044
						East	270	549907	0.0045

Table B-1. Continued.

INL Site Facility Area	SMA Code	Instrument Response Begin Date	End Date	NetDAS Serial #	Accelerometer Model	Orientation	Positive Direction	Counts/g	Trigger Level (g)
	FAS2	5/19/2004	12/31/2005	1083	SF2500A	Vertical	Down	545469	0.0046
						North	0	550078	0.0045
						East	270	562316	0.0044
MFC	EBR	6/2/2003	12/31/2005	1095	SF2500A	Vertical	Down	547675	0.0046
						North	0	554219	0.0045
						East	270	547920	0.0046
	FCF	6/2/2003	12/31/2005	1079	SF2500A	Vertical	Down	549212	0.0046
						North	0	559404	0.0045
						East	270	558307	0.0045
NRF	NRFF	12/23/2002	2/2/2005	1098	SF2500A	Vertical	Down	539329	0.0046
						North	0	552724	0.0045
						East	270	555587	0.0045
	NRFF	2/2/2005	8/23/2005	1098	SF2500A	Vertical	Down	540182	0.0046
						North	0	553738	0.0045
						East	270	551745	0.0045
	NRFF	8/23/2005	12/31/2005	1098	SF2500A	Vertical	Down	542167	0.0046
						North	0	552647	0.0045
						East	270	552261	0.0045
	A1W	1/22/2003	1/31/2005	1091	SF2500A	Vertical	Down	556354	0.0045
						North	0	564152	0.0044
						East	270	563802	0.0044

Table B-1. Continued.

		Instrument Response			Accelerometer				
INL Site Facility Area	SMA Code	Begin Date	End Date	NetDAS Serial #	Model	Orientation	Positive Direction	Counts/g	Trigger Level (g)
	A1W	1/31/2005	12/31/2005	1091	SF2500A	Vertical	Down	541217	0.0045
						North	0	570002	0.0044
						East	270	564995	0.0044
	S1W	1/22/2003	1/31/2005	1088	SF2500A	Vertical	Down	563302	0.0044
						North	0	557091	0.0045
						East	270	556344	0.0045
	S1W	1/31/2005	12/31/2005	1088	SF2500A	Vertical	Down	561125	0.0044
						North	0	558488	0.0045
						East	270	558473	0.0045
PBF	PBFF	6/7/2005	12/31/2005	1089	SF2500A	Vertical	Down	559223	0.0047
						North	0	553304	0.0045
						East	270	557374	0.0045
	ARAF	6/8/2005	12/13/2005	1082	SF2500A	Vertical	Down	530586	0.0045
						North	180	553243	0.0044
						East	90	550731	0.0042
RWMC	RWMC	5/6/2004	11/9/2004	1081	SF2500A	Vertical	Down	559481	0.0045
						North	0	576670	0.0043
						East	270	519859	0.0048
	RWMC	11/9/2005	12/31/2005	1081	SF2500A	Vertical	Down	556615	0.0045
						North	0	550661	0.0043
						East	270	572485	0.0048

Table B-1. Continued.

		Instrument Response			Accelerometer				
INL Site Facility Area	SMA Code	Begin Date	End Date	NetDAS Serial #	Model	Orientation	Positive Direction	Counts/g	Trigger Level (g)
	RWME	11/9/2005	12/31/2005	1077	SF2500A	Vertical	Down	558903	0.0044
						North	0	564951	0.0045
						East	270	557551	0.0045
RTC	TRAF	11/9/2004	9/1/2005	1094	SF2500A	Vertical	Down	525195	0.0048
						North	0	577435	0.0043
						East	270	554469	0.0045
	TRAF	9/1/2005	12/31/2005	1094	SF2500A	Vertical	Down	526114	0.0048
						North	0	574035	0.0043
						East	270	549477	0.0045
	TRA1	5/6/2004	12/31/2005	1092	SF2500A	Vertical	Down	539986	0.0046
						North	0	570784	0.0044
						East	270	549115	0.0046
	TRA2	5/6/2004	12/31/2005	1085	SF2500A	Vertical	Down	543172	0.0046
						North	0	556212	0.0045
						East	270	568860	0.0044
STC	IRC	12/16/2002	8/21/2003	1086	SF2500A	Vertical	Down	557263	0.0045
						North	0	572415	0.0044
						East	270	566145	0.0044
TAN	TANA	6/7/2005	12/31/2005	1090	SF2500A	Vertical	Down	553849	0.0045
						North	0	564675	0.0044
						East	270	530791	0.0042

Table B-1. Continued.

		Instrument Response			Accelerometer				
INL Site Facility Area	SMA Code	Begin Date	End Date	NetDAS Serial #	Model	Orientation	Positive Direction	Counts/g	Trigger Level (g)
	TAN1	5/4/2004	12/31/2005	1093	SF2500A	Vertical	Down	575282	0.0043
						North	0	576494	0.0043
						East	270	541081	0.0046
	TAN2	5/4/2004	12/31/2005	1087	SF2500A	Vertical	Down	573037	0.0044
						North	0	598256	0.0042
						East	270	553210	0.0045
	TAN3	5/4/2004	12/31/2004	1080	SF2500A	Vertical	Down	534052	0.0047
						North	0	543777	0.0046
						East	270	561958	0.0044

Table B-2. Instrument response of accelerometers located at seismic stations.

	Instrument Response			Accelerometer						
Seismic Station	Begin Date	End Date	NetDAS Serial #	Model #	Serial #	Orientation	Counts/Volt	Positive Direction	V/g	Counts/g
BCYI	10/28/2004	3/23/2005	1071	SF3000L	185	Vertical	839515	Up	1.220	1024208
						North	837795	0	1.200	1005354
						East	839496	90	1.220	1024185
BCYI	3/23/2005	12/31/2005	1071	SF3000L	185	Vertical	833601	Up	1.220	1016993
						North	837596	0	1.200	1005115
						East	833104	90	1.220	1016387
GRRI	11/9/2004	8/8/2005	1013	SF2500A	57	Vertical	818908	Up	1.396	1143196
						North	800256	37	1.345	1076344
						East	804890	127	1.412	1136505
GRRI	8/8/2005	12/31/2005	1013	SF2500A	57	Vertical	804275	Up	1.396	1122768
						North	872679	37	1.345	1173753
						East	863351	127	1.412	1219052
HWFI	6/9/2004	11/3/2005	1069	SF2500A	62	Vertical	804926	Up	1.378	1109188
						North	804787	37	1.371	1103363
						East	809507	127	1.352	1094453
HWFI	11/3/2005	12/31/2005	1069	SF2500A	62	Vertical	804003	Up	1.378	1107916
						North	805254	0	1.371	1104003
						East	809573	90	1.352	1094542
NPRI	10/7/2004	10/21/2005	1065	SF2500A	36	Vertical	837440	Up	1.427	1195027
						North	829229	37	1.376	1141019
						East	835391	127	1.371	1145321
NPRI	10/21/2005	12/31/2005	1065	SF2500A	36	Vertical	810927	Up	1.427	1157193
						North	802533	0	1.376	1104286
						East	808520	90	1.371	1108481

Table B-2. Continued.

	Instrument Response			Accelerometer						
Seismic Station	Begin Date	End Date	NetDAS Serial #	Model #	Serial #	Orientation	Counts/Volt	Positive Direction	V/g	Counts/g
PTI	11/10/2004	11/2/2005	1071	SF3000L	188	Vertical	837309	Up	1.230	1029890
						North	837818	37	1.194	1000355
						East	838386	127	1.244	1042952
PTI	11/2/2005	12/31/2005	1071	SF3000L	188	Vertical	805156	Up	1.230	990341
						North	806126	0	1.194	962514
						East	805836	90	1.244	1002460
SPCI	10/6/2004	6/13/2005	1070	SF3000L	186	Vertical	828767	Up	1.216	1007781
						North	827770	37	1.237	1023951
						East	829629	127	1.215	1007999
SPCI	6/13/2005	12/31/2005	1070	SF3000L	186	Vertical	806336	Up	1.216	980505
						North	806668	0	1.237	997848
						East	809144	90	1.215	983110
TCSI	6/9/2004	12/15/2005	1067	SF3000L	187	Vertical	806652	Up	1.216	980889
						North	804646	37	1.237	995347
						East	804796	127	1.215	977827

Appendix C

Instrument Response of Seismic Stations

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Appendix C

Instrument Response of Seismic Stations

C.1 Method for Determining Amplitude Response

The INL calibrated both the NetDAS four (4CH) and eight channel (8CH) NetDAS units. The INL establishes a DC counts/volt level by measuring a known voltage level for a specified duration of time for each channel on the NetDAS units and recording the mean and standard deviation in counts for this duration. The signal polarity is often reversed in order to obtain a greater measurement range. The mean provides the method to produce the DC counts/volt level (Equation C-1a and C-1b) and the standard deviation provides an idea of the measurement uncertainty and system noise.

Single ended:

$$\text{Counts/Volt} = \mu / v_i \qquad \text{[C-1a]}$$

Reversed Polarity:

$$\text{Counts/Volt} = (\mu+ - \mu^-) / (v_i+ - v_i^-) \qquad \text{[C-1b]}$$

Where:

μ is mean counts

v_i is input voltage

Subscript "+" is positive polarity

Subscript "– " is negative polarity

C.2 NetDAS-4CH Frequency Response

The response of the Symmetric Research PAR4CH (4CH) digitizer used in the NetDAS-4CH was based on vendor provided information, but calculated at the INL to establish the instrument response of NetDAS units. The vendor DAQSystems, Inc. of the NetDAS units reviewed INL's frequency response results and methods. These methods and results for the response information are provided in the following discussion.

The NetDAS-4CH frequency response was determined empirically by measuring a signal generating a constant amplitude sine wave and changing the frequency of the sine wave and at each step measuring the associated counts reported by the digitizer and NetDAS. This was done for representative frequencies of 0.1, 5, 10, 15, 20, 25, 30, and 35 Hz. This frequency sweep was done twice. The averages of the measured counts at each frequency was then converted into decibel response relative to the average 0.1 value since vendor supplied data states the gain at this frequency should be 1. A 2nd order polynomial was then fit to the data creating a simple amplitude response in frequency. The perfectly matched response (R-squared of one) is shown here as described by Equations C-2 and C-3 (conversion to decibels).

$$Y_{dB} = -0.0045f^2 + 0.0074f - 0.014 \qquad \text{[C-2]}$$

$$dB = 20 \log (E_2/E_1) \quad [C\text{-}3]$$

Where:

f – frequency (Hz)

E_1 – original signal level

E_2 - modified signal level

E_2/E_1 – commonly referred to as gain

This relationship was then used to calculate the gains to extend the gain frequency information out to the Nyquist frequency (1/2 the sample rate). The INL samples all data at 100 samples per second or Hz. The information was then entered into MATLAB, which has a function to determine poles and zeros. Poles and zeros notations are the form that many seismic applications use to remove the instrument response. The NetDAS-4CH frequency response in dB and poles and zeros are shown in Figure C-1.

Equations C-2 and C-3 can be used in conjunction with the DC counts/volt measurement to generate a count based frequency response for short hand calculations or spectral deconvolution to remove the frequency response.

$$Ycounts = Counts/Volt \times 10\text{^}((-0.0045f^2 + 0.0074f - 0.014)/20) \quad [C\text{-}4]$$

Where:

^ - Indicates 10 to the power of the number calculated in parentheses.

However, the preferred method for removing the frequency response from a recorded waveform is to use a seismic analysis package, such as SEISAN. This program recognizes the poles and zeros representation of instrument response, which quickly and accurately corrects recorded waveforms to actual ground motions.

C.3 NetDAS-8CH Frequency Response

The response of the Symmetric Research PAR24B (8CH) digitizer used in the NetDAS-8CH was based on vendor provided information, and calculated in the same method as described above for the PAR4CH. A 2nd order polynomial was fit to the data creating a simple amplitude response in frequency that matched the amplitude response (R-squared of 0.999). Equation C-5, listed below, is similar to Equation C-3 used for the response of the NetDAS-4CH. The NetDAS-8CH frequency response in dB and poles and zeros are shown in Figure C-2.

$$Y_{dB} = -0.0045f^2 + 0.0071f - 0.0158 \quad [C\text{-}5]$$

C.4 Short-period high-gain seismic stations

In the fall of 2002, INL seismic personnel began tracking instrument response of the seismic stations. Table C-1 lists the measured responses and amplification information for the seismic stations that have been measured for instrument responses.

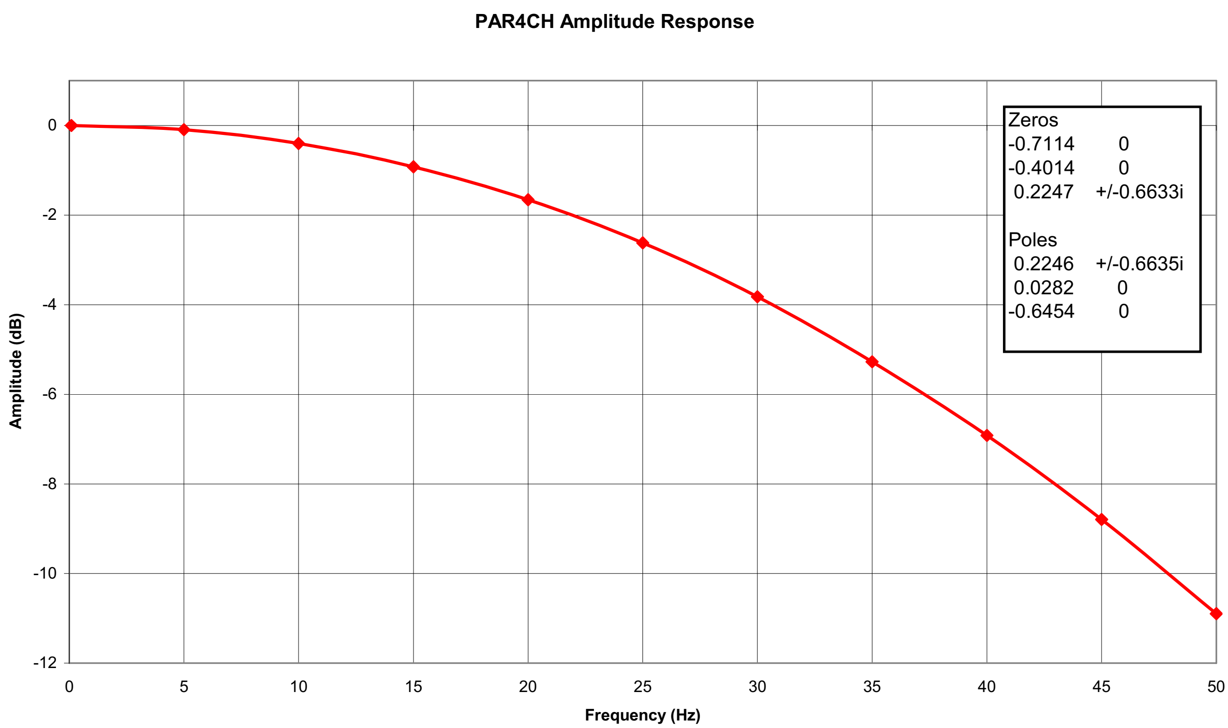

Figure C-1. Amplitude verses frequency system response of the Symmetric Research PAR4CH digitizer used in the NetDAS-4CH.

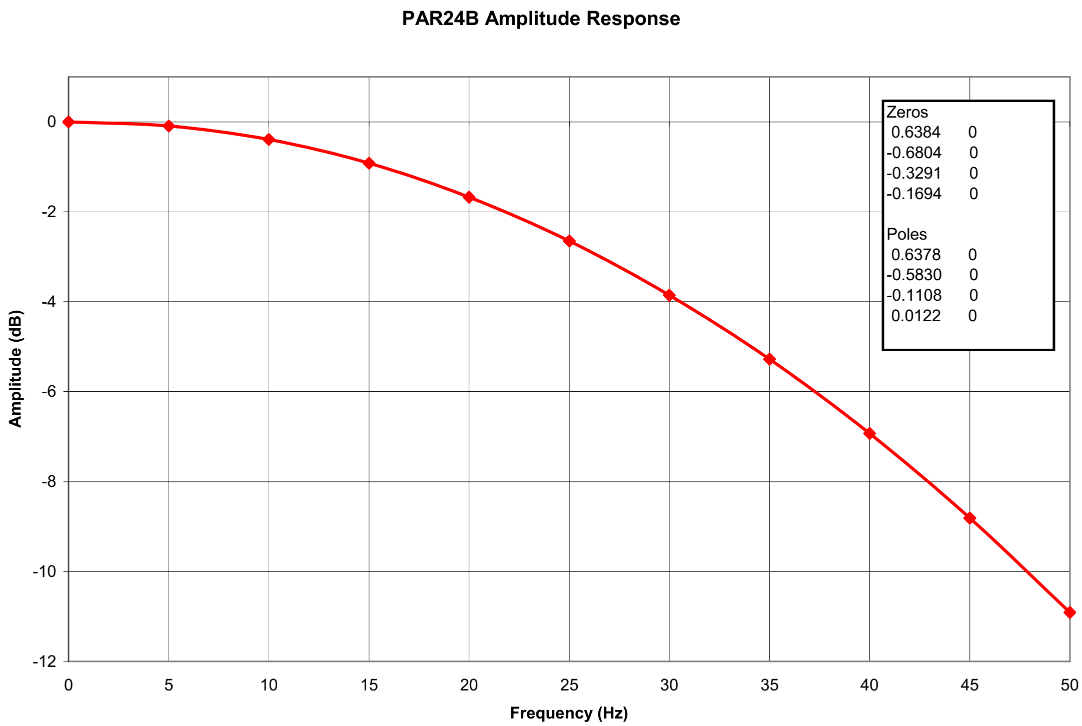

Figure C-2. Amplitude verses frequency system response of the Symmetric Research PAR24B digitizer used in the NetDAS-8CH.

Table C-1. Instrument response of seismometers located at seismic stations.

Seismic Station	Instrument Response Begin Date	End Date	NetDAS Serial #	Digitizer Model	Orientation	Counts/Volt	Amplifier Type	Gain	Seismometer Model
Single-component stations									
ARNI	1/1/2004	12/31/2005	1017	4CH	Vertical	NA	4CH	100	S13J
BCYI	10/28/2004	3/23/2005	1068	8CH	Vertical	839,401	4CH	100	S13J
BCYI	3/23/2005	12/31/2005	1068	8CH	Vertical	835,518	4CH	100	S13J
CBTI	10/6/2004	12/31/2005	1024	4CH	Vertical	480,777	4CH	100	S13J
COMI	10/6/2004	12/31/2005	2005	4CH	Vertical	387,088	INL18	90.2	S13
CNCI	10/7/2004	12/31/2005	1066	4CH	Vertical	476,017	4CH	100	L4C
CRBI	10/27/2004	12/31/2005	1027	4CH	Vertical	443,124	None	1	S13J
ECRI	11/11/2004	12/31/2005	1051	4CH	Vertical	434,299	None	1	S13
EMI	10/27/2004	12/31/2004	1019	4CH	Vertical	476,105	4CH	100	L4C
GBI	10/26/2004	5/18/2005	1026	4CH	Vertical	424,375	None	1	S13J
GBI	5/18/2005	12/31/2005	30802	24USB5V	Vertical	7,679,384	None	1	S13J
GRRI	1/20/2004	12/31/2005	1013	4CH	Vertical	48,023,820	INL9	108	S13J
GTRI	1/1/2005	12/31/2005	1021	4CH	Vertical	NA	INL16	90.2	S13J
HHAI	1/1/2005	12/31/2005	1019	4CH	Vertical	NA	4CH	100	S13J
HPI	8/16/2004	12/31/2005	1071	4CH	Vertical	472,446	4CH	100	L4C
ICI	10/27/2004	12/31/2005	1020	4CH	Vertical	477,973	4CH	100	L4C
KBI	1/1/2004	12/31/2005	1018	4CH	Vertical	NA	4CH	100	S13J
LJI	2/24/2004	12/31/2005	1052	4CH	Vertical	477,522	4CH	100	S13J
PZCI	6/16/2004	12/31/2005	1023	4CH	Vertical	399,981	INL13	106	S13J

Table C-1. Continued.

Seismic Station	Instrument Response Begin Date	End Date	NetDAS Serial #	Digitizer Model	Orientation	Counts/Volt	Amplifier Type	Gain	Seismometer Model
PTI	11/10/2004	11/2/2005	1071	8CH	Vertical	836,826	4CH	100	S13
PTI	11/2/2005	12/31/2005	1071	8CH	Vertical	804,150	4CH	100	S13
SMBI	8/24/2004	12/31/2005	1063	4CH	Vertical	447,541	None	1	S13J
Three-component stations									
HWFI	6/9/2004	11/3/2005	1069	8CH	Vertical	856,855	4CH	100	S13
					North	857,467	4CH	100	S13
					East	856,426	4CH	100	S13
HWFI	11/3/2005	12/312005	1069	8CH	Vertical	856,478	4CH	100	S13
					North	857,063	4CH	100	S13
					East	853,611	4CH	100	S13
IRCI	6/3/2005	12/31/2005	1012	4CH	Vertical	469,890	None	1	OYO
					North	461,125	None	1	S13
					East	467,680	None	1	S13
JGI	5/11/2004	5/10/2005	1010	4CH	Vertical	459,068	4CH	100	S13
					North	463,310	4CH	100	S13
					East	474,627	4CH	100	S13
JGI	5/10/2005	12/31/2005	30801	23USB5V	Vertical	2,722,002	None	1	S13
					North	2,730,140	None	1	S13
					East	2,738,391	None	1	S13

Table C-1. Continued.

Seismic Station	Instrument Response Begin Date	End Date	NetDAS Serial #	Digitizer Model	Orientation	Counts/Volt	Amplifier Type	Gain	Seismometer Model
LLRI	10/7/2004	12/31/2005	1029	4CH	Vertical	479,710	4CH	100	S13J
					North	485,322	4CH	100	S13
					East	483,647	4CH	100	S13
NPRI	10/7/2004	10/21/2005	1065	8CH	Vertical	856,746	4CH	100	S13J
					North	857,992	4CH	100	S13
					East	861,760	4CH	100	S13
NPRI	10/21/2005	12/31/2005	1065	8CH	Vertical	836,486	4CH	100	S13J
					North	837,155	4CH	100	S13
					East	839,175	4CH	100	S13
SPCI	10/6/2004	12/31/2004	1070	8CH	Vertical	826,710	None	1	S13J
					North	827,449	INL22	102	S13
					East	828,404	INL17	102	S13
SPCI	6/13/2005	12/31/2005	1070	8CH	Vertical	827,660	None	1	S13J
					North	827,077	4CH	100	S13
					East	829,743	4CH	100	S13
TCSI	6/9/2004	12/31/2004	1067	8CH	Vertical	804,178	INL16	90.2	S13
					North	804,672	INL99	94.5	S13
					East	805,572	INL12	91	S13
TCSI	8/16/2005	12/31/2005	1067	24USB5V	Vertical	2,642,927	None	1	S13
					North	2,642368	None	1	S13
					East	2,635,268	None	1	S13

Table C-1. Continued.

	Instrument Response								
Seismic Station	Begin Date	End Date	NetDAS Serial #	Digitizer Model	Orientation	Counts/Volt	Amplifier Type	Gain	Seismometer Model
TMI	10/21/2004	12/31/2004	2004	4CH	Vertical	477,351	4CH	100	S13
					North	470,004	4CH	100	S13
					East	475,647	4CH	100	S13
TMI	8/1/2005	12/31/2005	2004	24USB5V	Vertical	2,226,262	None	1	S13
					North	2,198,172	None	1	S13
					East	2,194,452	None	1	S13

Appendix D

2005 Earthquake List

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Appendix D

2005 Earthquake List

The summary list of earthquakes includes those located within a 161-km (100-mile) radius of the INL centered at 43.0° 39.00' N, 112° 47.00' W. Table D-1 provides an explanation of the headings listed in Table D-2 for the earthquake list. The format for this table has been modified from previous years. The earthquake identification number is no longer reported since the SEISAN analysis package identification number is simply the origin data and time. The listing also includes the distance of the earthquake epicenter from the center of INL.

Table D-1. Explanation of the earthquake summary table headings.

Heading	Example	Explanation
ORIGIN	1/1/2005 19:27	Date of the earthquake: month/day/year (1/1/2005); origin time of the earthquake: hour and minute in UTC (19:27)
LAT N	44.2477	Latitude of epicenter in degrees North
LONG W	113.9370	Longitude of epicenter in degrees West
MAG	1.40	Coda magnitude (M_c) of the earthquake as determined under Section 4.2 unless otherwise indicated by a B for BUT, N for NEIC, R for U.S. Bureau of Reclamation (USB), E for BSE, S for SLC, or I for INL, a measured local magnitude (M_L).
TYPE	Mc INL	Type of magnitude reported and reporting agency. Magnitude types: Coda magnitude (Mc); Local magnitude (ML); Moment magnitude (Mw); and Body wave magnitude (mb). Reporting agencies include: Idaho National Laboratory (INL); NEIC (US); University of Utah (UU); and Montana Bureau of Mines and Geology (MB).
DIST	113.99	Distance in km from center of INL at: 43° 39.00' N, 112° 47.00' W.
Z	6.68	Calculated focal depth in km. Some earthquakes have appropriate seismic station geometry for calculating a reliable focal depth.
NO	8	Number of station readings used in locating the earthquake with weights above 0.1. P- and S-wave arrival times for the same station are regarded as two readings.
GAP	250	Largest azimuthal separation in degrees between stations.
DMIN	52.6	Distance in km from the epicenter to the nearest station.
RMS	0.19	Root mean square error of time residuals in second using all weights as calculated by: $RMS=\sqrt{R_i^2}/NO$
		Where: R_i is the time residual for the i^{th} station.
ERH	2.34	Standard horizontal error of the epicenter in km.
ERZ	4.94	Standard vertical error of the focal depth in km.

Table D-2. Earthquakes located within 161-km radius of INL in 2005.

ORIGIN TIME	LAT N	LONG W	MAG -TYPE	DIST	Z	NO	GAP	DMIN	RMS	ERH	ERZ
1/1/2005 19:27	44.2477	113.9370	1.40 Mc INL	113.99	6.68	8	250	52.6	0.19	2.34	4.94
1/2/2005 13:15	44.0740	113.8948	1.30 Mc INL	101.02	4.05	4	314	39.0	0.22	8.86	18.51
1/3/2005 13:16	44.7833	112.5420	1.80 Mc INL	127.54	6.91	4	262	119.5	0.04	3.45	6.89
1/5/2005 21:15	44.2760	114.3297	1.80 Mc INL	142.28	0.31	8	275	80.2	0.11	4.25	8.56
1/6/2005 20:02	44.3420	113.9773	2.50 Mc INL	122.86	0.82	14	233	62.3	0.16	1.08	3.06
1/6/2005 20:18	44.2782	113.9355	1.10 Mc INL	115.89	7.29	5	208	54.9	0.10	1.06	14.89
1/6/2005 20:33	44.3377	113.9763	1.10 Mc INL	122.50	6.80	7	216	61.9	0.11	0.94	3.95
1/11/2005 8:06	44.7118	112.0203	1.40 Mc INL	132.93	6.30	5	208	32.5	0.11	0.90	14.12
1/11/2005 20:28	44.6250	112.0878	1.40 Mc INL	121.89	0.71	7	192	24.6	0.08	1.00	1.32
1/13/2005 17:59	44.3188	113.8653	1.60 Mc INL	114.31	0.94	6	272	36.7	0.06	1.15	1.36
1/14/2005 0:20	44.2595	114.3733	1.90 Mc INL	144.48	0.10	8	239	77.5	0.12	2.11	2.39
1/14/2005 19:16	44.3645	113.9915	2.30 Mc INL	125.30	0.99	21	219	47.1	0.16	0.97	2.53
1/15/2005 21:02	44.6362	112.6088	1.30 Mc INL	110.60	6.60	4	146	17.7	0.03	0.93	12.08
1/16/2005 3:21	44.6703	112.5508	1.70 Mc INL	115.02	8.88	15	137	15.1	0.05	0.30	1.21
1/17/2005 1:38	42.7300	111.9098	0.70 Mc INL	124.53	5.01	3	217	56.9	0.05	2.32	13.17
1/17/2005 13:49	44.7115	112.6008	1.50 Mc INL	118.99	6.76	5	333	100.9	0.04	2.05	4.83
1/18/2005 18:35	44.2823	114.5570	1.50 Mc INL	158.73	0.04	8	254	80.9	0.09	1.65	2.28
1/19/2005 8:17	44.4218	112.4610	0.00 Mc INL	89.65	10.48	18	201	14.6	0.16	0.75	1.12
1/19/2005 8:22	44.4288	112.4708	1.70 Mc INL	90.18	6.27	15	170	15.7	0.11	0.93	4.07
1/19/2005 8:50	44.4398	112.4717	2.00 Mc INL	91.34	5.67	15	172	16.5	0.09	0.98	3.20
1/19/2005 9:01	44.4157	112.4822	0.60 Mc INL	88.53	4.64	3	226	15.5	0.07	5.73	9.90
1/19/2005 9:40	44.3958	112.4878	1.00 Mc INL	86.28	4.75	6	211	14.9	0.07	6.44	11.47
1/19/2005 17:20	42.5180	111.8652	1.30 Mc INL	146.42	11.86	9	102	45.1	0.15	0.56	2.37
1/19/2005 20:53	44.2758	114.3325	1.40 Mc INL	142.46	3.43	3	236	74.1	0.26	3.34	7.22
1/20/2005 23:56	44.7702	111.8295	1.10 Mc INL	146.05	7.49	5	175	13.7	0.04	1.39	3.42
1/21/2005 21:57	44.5068	113.0402	1.40 Mc INL	97.52	10.29	5	148	21.2	0.12	0.90	4.46
1/23/2005 4:54	44.7288	112.4860	1.00 Mc INL	122.34	4.06	5	222	16.7	0.02	2.34	1.88
1/23/2005 19:47	44.2778	114.5818	2.30 Mc INL	160.30	0.08	13	256	80.7	0.32	2.32	3.12
1/24/2005 20:23	44.2678	114.3800	1.80 Mc INL	145.38	0.79	8	240	78.0	0.23	1.37	2.39
1/28/2005 18:23	42.7665	111.5355	1.00 Mc INL	141.16	5.01	4	189	34.6	0.10	1.06	13.58
1/29/2005 7:34	44.6745	112.5073	1.80 Mc INL	116.09	5.06	10	141	12.7	0.06	0.50	1.09
1/29/2005 8:20	44.3478	113.9555	1.60 Mc INL	121.91	7.07	9	215	44.1	0.05	0.65	13.18
1/29/2005 8:28	44.3660	114.0002	3.00 ML US	125.95	7.09	19	219	47.8	0.23	1.11	1.93
1/29/2005 9:50	44.3535	113.9678	1.20 Mc INL	123.07	8.58	9	216	45.1	0.08	0.74	1.32
1/31/2005 19:32	44.2618	114.0233	1.90 Mc INL	120.55	0.02	7	257	49.6	0.15	1.57	2.41
2/1/2005 10:08	44.3052	114.1150	2.00 Mc INL	129.32	1.35	8	264	56.6	0.29	7.04	9.42
2/1/2005 20:49	44.2642	114.5523	2.00 Mc INL	157.53	0.62	8	310	95.7	0.28	7.86	7.64
2/2/2005 0:52	44.3033	113.8852	1.00 Mc INL	114.43	0.04	8	282	38.3	0.07	2.33	2.70
2/2/2005 3:58	44.5357	112.0490	1.00 Mc INL	114.72	4.32	4	180	28.2	0.08	0.72	1.83
2/3/2005 0:16	44.2450	114.3252	2.00 Mc INL	140.33	0.08	16	235	73.8	0.24	1.20	1.71
2/3/2005 12:24	44.4427	114.1025	1.30 Mc INL	137.65	7.38	5	231	57.5	0.06	0.91	13.48
2/4/2005 20:48	44.3697	113.9353	3.00 ML US	122.23	1.76	17	277	42.8	0.14	1.04	0.84
2/4/2005 21:17	44.3318	113.9327	1.40 Mc INL	119.37	2.38	4	262	42.2	0.08	1.08	0.89
2/5/2005 2:16	44.3682	113.9308	1.90 Mc INL	121.85	1.52	12	262	42.4	0.12	1.01	1.93
2/5/2005 2:18	44.3553	113.9425	0.00 Mc INL	121.64	7.32	7	276	43.1	0.19	1.70	4.70

Table D-2. Continued.

ORIGIN TIME	LAT N	LONG W	MAG -TYPE		DIST	Z	NO	GAP	DMIN	RMS	ERH	ERZ
2/6/2005 4:36	44.6768	112.0707	1.20	Mc INL	127.64	4.15	4	153	27.3	0.16	0.83	1.47
2/7/2005 11:25	44.4588	112.8800	1.30	Mc INL	90.31	12.49	11	114	15.2	0.11	0.39	1.09
2/8/2005 5:58	44.6278	112.1103	2.00	Mc INL	121.36	12.94	16	140	22.9	0.13	0.45	1.04
2/8/2005 15:18	44.5378	112.3877	0.80	Mc INL	103.71	4.88	3	169	6.2	0.08	5.43	3.41
2/10/2005 17:11	44.3335	113.9118	1.20	Mc INL	118.21	5.36	7	260	40.5	0.07	3.17	6.98
2/10/2005 21:56	44.3582	113.9890	1.70	Mc INL	124.71	0.05	18	218	46.9	0.11	0.67	1.12
2/11/2005 0:15	44.4057	114.0593	1.30	Mc INL	132.39	6.58	10	226	71.9	0.26	2.15	4.13
2/13/2005 2:39	44.6300	112.0953	1.20	Mc INL	122.11	4.48	6	149	24.1	0.21	1.09	1.37
2/15/2005 8:42	44.3482	113.9885	1.90	Mc INL	123.99	1.53	11	217	63.4	0.14	0.80	1.26
2/17/2005 3:12	43.6947	111.1407	2.90	ML US	132.47	11.77	32	156	55.2	0.07	0.24	0.43
2/17/2005 4:21	43.6970	111.1555	1.70	Mc INL	131.29	9.43	22	171	54.9	0.12	0.46	0.62
2/17/2005 9:58	44.9865	112.2353	1.40	Mc INL	154.97	4.23	6	213	45.5	0.05	0.84	3.66
2/18/2005 3:05	43.6987	111.1398	1.90	Mc INL	132.56	12.02	29	173	54.7	0.13	0.46	0.55
2/18/2005 8:50	44.6423	112.1903	1.10	Mc INL	120.14	17.22	7	184	17.1	0.05	0.89	1.20
2/20/2005 16:52	44.0438	114.5752	2.10	Mc INL	150.56	5.92	13	270	55.2	0.04	6.97	8.45
2/20/2005 19:54	44.3612	113.9408	1.40	Mc INL	121.95	5.33	10	215	79.8	0.19	1.10	2.58
2/21/2005 0:39	43.6895	111.1548	1.70	Mc INL	131.32	8.05	20	154	55.7	0.14	0.49	0.74
2/22/2005 0:53	43.6845	111.0850	1.70	Mc INL	136.93	11.31	12	221	68.9	0.16	1.48	1.37
2/23/2005 3:39	44.3733	114.0172	1.70	Mc INL	127.51	4.83	19	221	49.3	0.30	1.15	2.40
2/23/2005 13:27	44.5108	112.3215	0.40	Mc INL	102.64	0.94	4	256	10.8	0.03	5.42	11.12
2/25/2005 1:37	44.6040	112.4127	1.90	Mc INL	110.19	8.51	25	134	1.9	0.09	0.26	0.55
2/25/2005 22:47	44.3617	113.9977	2.00	Mc INL	125.49	6.18	21	219	47.6	0.24	0.77	2.77
2/26/2005 4:13	44.3150	112.5993	1.10	Mc INL	75.43	2.35	16	113	22.7	0.11	0.40	1.20
2/26/2005 4:48	44.3308	113.1807	0.50	Mc INL	82.18	6.27	9	122	18.1	0.10	0.45	0.64
3/5/2005 13:41	44.3432	114.0547	1.60	Mc INL	127.83	5.63	6	221	91.2	0.05	7.95	6.09
3/7/2005 0:06	44.1908	114.1070	0.60	Mc INL	122.13	5.31	3	214	73.8	0.03	11.38	5.75
3/7/2005 23:40	44.3507	113.9597	1.50	Mc INL	122.37	6.93	10	215	44.4	0.20	0.93	6.98
3/9/2005 2:40	44.6675	111.9705	1.70	Mc INL	130.51	9.50	22	148	25.1	0.13	0.53	2.83
3/9/2005 7:38	44.6505	111.9608	1.10	Mc INL	129.27	6.02	9	143	25.0	0.05	0.51	8.86
3/9/2005 18:55	42.9037	111.3207	0.00	Mc INL	144.81	2.00	4	177	9.1	0.05	1.89	13.09
3/14/2005 3:49	42.5060	111.6473	1.00	Mc INL	157.29	5.01	6	175	44.7	0.10	0.98	13.99
3/14/2005 6:07	42.5158	111.6205	0.80	Mc INL	157.71	2.49	5	174	46.3	0.11	1.08	15.68
3/14/2005 23:26	42.8630	111.3682	1.30	Mc INL	144.40	2.00	9	116	9.4	0.20	2.02	20.75
3/16/2005 22:19	44.7858	112.8648	1.30	Mc INL	126.53	3.94	9	188	4.8	0.06	7.12	9.40
3/17/2005 0:56	44.3362	113.9673	1.20	Mc INL	121.83	6.95	7	215	61.3	0.16	0.83	18.45
3/18/2005 10:27	44.0138	113.6952	1.80	Mc INL	83.76	0.11	20	166	21.7	0.30	1.64	2.65
3/18/2005 21:08	44.3275	114.0320	1.20	Mc INL	125.34	4.12	7	249	64.2	0.05	1.82	4.66
3/19/2005 15:39	44.3528	113.9497	1.60	Mc INL	121.90	7.39	9	215	61.7	0.23	0.92	23.09
3/20/2005 8:05	44.3530	113.9692	1.10	Mc INL	123.12	2.79	6	216	62.8	0.12	1.00	2.56
3/21/2005 18:30	44.1635	113.1752	1.20	Mc INL	65.23	2.52	7	176	22.3	0.21	0.82	2.26
3/21/2005 22:48	44.6723	112.1608	1.50	Mc INL	124.13	13.74	15	152	20.5	0.22	0.70	0.83
3/22/2005 6:13	44.8283	113.6967	2.10	Mc INL	150.02	0.01	22	246	67.0	0.31	1.77	2.18
3/22/2005 8:25	44.8412	113.6805	2.20	Mc INL	150.65	0.77	24	248	65.8	0.29	1.72	2.27
3/22/2005 13:53	44.2687	114.0723	2.00	Mc INL	124.24	6.96	23	217	62.4	0.25	1.05	1.59
3/23/2005 17:35	44.2578	114.3802	1.20	Mc INL	144.88	0.02	9	239	77.3	0.29	2.42	3.51
3/24/2005 15:06	43.7052	111.1507	1.50	Mc INL	131.71	11.72	15	171	54.0	0.08	0.50	0.84

Table D-2. Continued.

ORIGIN TIME	LAT N	LONG W	MAG -TYPE	DIST	Z	NO	GAP	DMIN	RMS	ERH	ERZ
3/25/2005 9:00	44.9735	112.1235	1.40 Mc INL	156.35	4.59	9	209	45.2	0.34	1.77	8.04
3/25/2005 22:50	42.7990	111.4750	1.20 Mc INL	142.28	2.48	7	279	16.0	0.02	3.30	12.38
3/26/2005 12:42	44.3420	112.7375	1.70 Mc INL	77.07	5.78	25	85	16.3	0.11	0.29	0.73
3/28/2005 1:11	44.8025	113.1715	1.20 Mc INL	131.92	1.25	6	249	25.7	0.27	3.57	4.68
3/31/2005 10:35	44.2733	114.1288	3.10 ML US	128.31	2.67	33	222	66.4	0.20	0.67	2.24
3/31/2005 22:26	42.8495	111.3713	0.80 Mc INL	145.12	2.52	6	207	10.7	0.12	2.29	14.12
4/1/2005 5:27	44.4937	112.6743	1.50 Mc INL	94.26	5.99	15	110	24.9	0.12	0.41	15.41
4/5/2005 4:27	42.6965	111.3097	0.80 Mc INL	159.96	10.36	7	218	18.8	0.08	0.92	3.36
4/6/2005 8:11	44.5922	112.5063	0.60 Mc INL	107.13	2.49	6	134	8.9	0.21	8.76	17.88
4/6/2005 10:10	43.7672	111.0690	1.80 Mc INL	138.69	10.30	21	214	47.9	0.12	0.49	0.70
4/6/2005 19:52	43.7793	111.0595	1.90 Mc INL	139.57	12.87	20	178	46.7	0.11	0.44	0.89
4/7/2005 7:06	43.7917	111.1488	1.80 Mc INL	132.56	8.87	15	166	44.4	0.09	0.87	1.36
4/8/2005 0:59	43.7808	111.1230	1.50 Mc INL	134.50	10.98	17	176	45.7	0.16	1.03	0.69
4/8/2005 1:14	43.7795	111.1103	1.50 Mc INL	135.50	10.28	16	178	46.0	0.09	0.77	0.69
4/8/2005 1:16	43.7732	111.1083	0.90 Mc INL	135.60	4.05	6	209	46.7	0.10	0.86	2.32
4/8/2005 4:52	43.7890	111.1490	1.70 Mc INL	132.51	9.44	9	201	44.7	0.12	1.03	2.08
4/8/2005 6:08	43.7783	111.1182	1.20 Mc INL	134.86	2.59	6	238	46.1	0.12	0.81	15.87
4/9/2005 4:59	43.7867	111.1243	1.10 Mc INL	134.46	1.96	5	256	83.5	0.21	2.47	3.10
4/9/2005 8:28	43.7760	111.0818	1.90 Mc INL	137.75	13.08	14	176	46.7	0.12	0.93	0.85
4/10/2005 2:05	43.7860	111.0708	2.00 Mc INL	138.74	12.38	22	184	45.8	0.10	0.45	0.53
4/10/2005 4:46	43.7840	111.1435	1.60 Mc INL	132.89	9.88	16	196	45.3	0.06	0.67	1.55
4/10/2005 10:35	43.7802	111.1313	1.50 Mc INL	133.83	4.09	8	199	45.8	0.14	1.06	1.57
4/10/2005 18:58	44.3437	112.7363	1.60 Mc INL	77.26	6.30	21	86	16.4	0.07	0.38	0.93
4/10/2005 19:40	43.7640	111.0885	1.70 Mc INL	137.10	7.27	12	213	48.0	0.14	0.75	1.35
4/11/2005 4:45	42.7037	111.4312	0.90 Mc INL	152.15	3.07	12	130	26.0	0.10	0.49	13.56
4/11/2005 17:57	44.3425	113.9788	1.60 Mc INL	122.99	5.36	16	216	62.4	0.23	0.91	2.26
4/12/2005 13:52	43.7168	113.8088	1.20 Mc INL	83.00	1.69	16	154	28.8	0.34	0.84	1.75
4/13/2005 5:43	44.6250	112.1002	1.80 Mc INL	121.44	10.89	24	139	23.6	0.14	0.48	1.47
4/13/2005 12:33	43.7645	111.1427	1.60 Mc INL	132.75	2.27	10	266	47.4	0.08	0.74	2.08
4/14/2005 9:47	43.7802	111.1357	1.60 Mc INL	133.48	6.41	20	169	45.7	0.21	0.64	1.93
4/14/2005 21:30	42.8930	111.3888	0.80 Mc INL	141.03	2.00	8	116	5.7	0.33	2.22	29.85
4/15/2005 9:50	44.1620	114.0075	1.10 Mc INL	113.62	6.70	17	204	50.9	0.32	1.24	2.95
4/16/2005 16:12	42.6828	111.4547	1.60 Mc INL	152.42	1.04	17	95	28.5	0.13	0.46	1.23
4/17/2005 6:19	43.7770	111.1422	1.70 Mc INL	132.92	8.57	16	168	46.0	0.10	0.87	2.46
4/17/2005 8:06	42.6468	111.4192	1.20 Mc INL	157.32	8.80	8	145	29.2	0.12	0.62	3.73
4/17/2005 10:41	43.7900	111.1755	1.20 Mc INL	130.40	1.04	5	229	44.5	0.10	1.55	1.47
4/19/2005 4:03	44.7638	113.8143	2.10 Mc INL	148.80	0.79	20	244	59.9	0.14	1.04	1.18
4/20/2005 22:27	44.3033	111.0163	1.50 Mc INL	159.23	3.04	19	195	18.3	0.07	0.78	11.02
4/21/2005 13:07	44.3870	114.4828	1.90 Mc INL	158.99	5.36	3	252	91.8	0.21	15.03	15.13
4/24/2005 3:37	44.5687	112.1338	1.10 Mc INL	114.65	8.22	9	179	20.9	0.08	0.86	5.60
4/24/2005 18:00	44.4350	114.4493	1.30 Mc INL	159.51	3.90	3	253	97.0	0.23	15.94	16.23
4/25/2005 21:09	42.7587	111.5390	0.60 Mc INL	141.57	2.51	4	294	22.1	0.05	2.79	13.03
4/26/2005 9:28	43.7705	111.0445	1.90 Mc INL	140.69	13.30	22	180	47.9	0.09	0.38	0.37
4/27/2005 1:05	43.7867	111.1195	1.00 Mc INL	134.85	3.66	4	237	45.1	0.08	1.25	13.63
4/27/2005 4:45	43.7720	111.0490	1.20 Mc INL	140.34	13.80	6	220	47.7	0.04	1.88	0.55
4/27/2005 10:54	43.7883	111.1120	1.40 Mc INL	135.46	5.42	11	178	45.0	0.07	0.74	3.33

Table D-2. Continued.

ORIGIN TIME	LAT N	LONG W	MAG -TYPE	DIST	Z	NO	GAP	DMIN	RMS	ERH	ERZ
4/27/2005 21:10	42.8430	111.3470	1.20 Mc INL	147.13	1.59	6	206	12.2	0.33	2.18	4.45
4/28/2005 17:27	43.7980	111.1368	1.50 Mc INL	133.60	3.84	12	167	43.7	0.10	0.58	1.63
4/28/2005 20:47	43.7848	111.1183	0.90 Mc INL	134.92	10.07	4	237	45.3	0.12	2.96	2.49
4/28/2005 20:53	42.5645	111.5005	0.90 Mc INL	159.59	5.00	7	151	39.7	0.21	0.93	15.37
4/28/2005 21:09	42.5790	111.5567	1.00 Mc INL	155.39	9.25	9	98	42.7	0.13	0.48	5.46
4/28/2005 21:19	43.7598	111.0465	2.20 Mc INL	140.43	12.27	31	191	49.1	0.05	0.74	0.48
4/28/2005 22:22	42.5618	111.5642	0.70 Mc INL	156.48	5.00	3	185	52.6	0.19	2.14	18.20
4/29/2005 1:19	43.7682	111.0383	1.80 Mc INL	141.16	14.44	21	191	48.3	0.05	0.57	0.39
4/29/2005 13:54	43.7765	111.0458	1.70 Mc INL	140.64	14.01	16	189	47.3	0.04	0.68	0.45
4/29/2005 15:56	43.7742	111.0578	1.50 Mc INL	139.65	14.37	8	187	47.3	0.13	1.37	0.80
4/30/2005 3:12	43.7830	111.0880	0.80 Mc INL	137.33	14.64	6	182	45.9	0.12	1.83	2.08
4/30/2005 15:04	43.7727	111.0223	1.60 Mc INL	142.49	13.26	16	193	48.1	0.08	0.77	0.44
4/30/2005 19:54	44.5125	112.8145	0.60 Mc INL	95.99	6.85	4	170	22.7	0.09	1.08	2.51
4/30/2005 21:26	43.7795	111.0915	2.00 Mc INL	137.01	11.86	25	182	46.2	0.07	0.78	0.40
4/30/2005 21:52	43.7778	111.1563	1.50 Mc INL	131.80	2.50	13	171	45.9	0.08	0.51	11.33
4/30/2005 22:01	43.7797	111.0892	2.00 Mc INL	137.19	11.22	28	159	46.2	0.13	0.47	0.61
5/1/2005 9:09	43.7817	111.0948	0.80 Mc INL	136.77	4.78	4	240	45.9	0.13	1.14	2.15
5/1/2005 13:32	43.7635	111.0470	2.00 Mc INL	140.42	12.75	26	165	48.7	0.05	0.58	0.30
5/1/2005 21:25	43.7647	111.0643	2.00 Mc INL	139.04	9.47	32	162	48.2	0.18	0.67	1.22
5/1/2005 22:14	43.7727	111.0432	1.60 Mc INL	140.81	12.71	16	190	47.7	0.10	0.94	0.56
5/2/2005 0:54	43.7572	111.1172	2.00 Mc INL	134.73	3.29	17	250	48.4	0.09	0.77	1.03
5/2/2005 7:38	44.3632	114.0078	1.90 Mc INL	126.23	4.40	15	220	48.4	0.28	1.17	3.38
5/2/2005 8:23	43.9443	114.5807	2.10 Mc INL	148.26	0.07	23	270	44.7	0.04	3.39	3.73
5/2/2005 13:58	43.7682	111.0635	1.40 Mc INL	139.14	8.56	8	245	47.9	0.20	1.65	1.36
5/2/2005 21:20	43.7587	111.0508	1.60 Mc INL	140.07	10.39	9	216	49.1	0.10	0.68	1.13
5/2/2005 21:57	42.7875	111.4973	1.10 Mc INL	141.80	2.29	5	285	17.8	0.03	2.22	12.10
5/3/2005 0:42	43.7687	111.0812	0.80 Mc INL	137.73	3.27	5	213	47.6	0.12	1.20	14.97
5/3/2005 12:22	43.8083	111.0627	1.90 Mc INL	139.65	17.21	27	176	43.5	0.07	0.43	11.73
5/3/2005 13:25	43.7597	111.1205	0.80 Mc INL	134.49	0.21	4	243	48.1	0.09	2.53	4.18
5/3/2005 16:03	44.5707	112.1767	1.30 Mc INL	113.34	12.87	9	178	17.5	0.13	0.73	1.19
5/4/2005 3:09	43.7563	111.0318	1.30 Mc INL	141.58	13.96	11	193	49.7	0.06	1.07	0.55
5/4/2005 18:16	43.7595	111.0475	2.00 Mc INL	140.35	11.30	25	191	49.1	0.07	0.55	0.53
5/5/2005 19:57	44.7605	111.5310	0.80 Mc INL	158.95	11.97	3	263	11.2	0.01	1.54	2.59
5/6/2005 5:07	43.0267	111.3297	0.90 Mc INL	136.69	8.42	11	148	4.5	0.05	0.48	0.69
5/6/2005 13:54	43.7820	111.1300	1.80 Mc INL	133.95	8.36	15	169	45.6	0.12	0.88	2.56
5/7/2005 1:12	43.7658	111.0585	0.80 Mc INL	139.52	9.58	7	245	48.2	0.14	1.21	1.20
5/7/2005 7:53	43.7678	111.0493	1.50 Mc INL	140.27	13.12	7	189	48.2	0.05	1.11	0.69
5/7/2005 17:22	43.7828	111.0995	0.70 Mc INL	136.40	5.05	4	180	45.8	0.11	1.60	13.97
5/7/2005 21:37	43.7745	111.0455	1.40 Mc INL	140.64	2.50	7	189	47.5	0.08	1.16	13.17
5/10/2005 23:42	43.7722	111.0802	1.30 Mc INL	137.84	10.45	7	184	47.2	0.12	0.91	2.76
5/12/2005 4:00	44.6037	112.5857	1.70 Mc INL	107.27	11.24	16	133	15.2	0.09	0.38	1.37
5/12/2005 11:48	43.7652	111.0378	1.30 Mc INL	141.17	8.02	7	217	48.7	0.06	0.81	1.50
5/13/2005 8:35	42.7090	111.7773	1.80 Mc INL	132.81	4.92	19	68	50.7	0.26	0.42	9.80
5/14/2005 3:33	43.7722	111.0648	1.70 Mc INL	139.07	13.59	7	186	47.4	0.09	1.27	1.52
5/14/2005 13:21	43.7980	111.1680	0.80 Mc INL	131.10	19.88	7	193	43.6	0.21	3.54	10.69
5/16/2005 6:37	43.7500	111.0662	2.00 Mc INL	138.77	10.38	22	216	49.8	0.13	0.78	0.63

Table D-2. Continued.

ORIGIN TIME	LAT N	LONG W	MAG -TYPE	DIST	Z	NO	GAP	DMIN	RMS	ERH	ERZ
5/16/2005 12:59	44.5370	112.1522	1.50 Mc INL	110.84	3.18	7	133	20.2	0.25	0.74	1.19
5/16/2005 16:12	44.5540	112.1892	1.80 Mc INL	111.23	11.56	16	134	16.9	0.14	0.45	1.33
5/19/2005 15:03	44.0053	114.6645	1.50 Mc INL	156.34	7.38	8	273	53.4	0.07	1.00	8.35
5/19/2005 15:31	43.7945	111.1767	0.80 Mc INL	130.36	14.30	6	162	44.0	0.14	1.25	0.89
5/19/2005 21:07	42.7047	111.6577	1.10 Mc INL	139.36	5.01	4	298	32.3	0.10	2.26	14.00
5/24/2005 16:10	43.7543	111.0108	1.70 Mc INL	143.25	5.04	9	196	50.4	0.04	1.25	11.58
5/26/2005 19:59	42.6897	111.6217	1.80 Mc INL	142.55	5.02	13	86	43.5	0.13	0.77	15.74
5/27/2005 9:13	44.5300	113.0977	1.20 Mc INL	101.09	8.02	6	211	38.5	0.12	1.34	15.70
5/27/2005 17:07	44.3778	112.4862	1.00 Mc INL	84.39	5.17	5	170	14.1	0.00	3.27	6.03
5/28/2005 10:36	44.1542	113.1195	1.00 Mc INL	62.26	6.25	10	152	17.8	0.07	0.53	1.01
5/29/2005 2:51	42.6795	111.4732	1.40 Mc INL	151.63	8.88	10	94	32.0	0.17	0.54	2.22
5/30/2005 7:53	44.5982	112.1640	1.20 Mc INL	116.53	2.06	10	133	18.3	0.09	0.38	0.87
5/30/2005 14:28	44.5883	112.1768	1.20 Mc INL	115.10	12.13	7	135	17.3	0.28	1.04	3.06
5/30/2005 17:14	42.9218	111.3585	1.90 Mc INL	141.12	8.84	25	161	5.5	0.09	0.55	0.79
6/1/2005 2:22	43.8052	111.1115	1.50 Mc INL	135.71	8.78	6	239	57.3	0.15	1.00	1.13
6/2/2005 3:44	44.6108	112.0908	1.80 Mc INL	120.38	5.25	22	135	24.2	0.18	0.51	1.91
6/2/2005 16:41	44.3838	112.6423	1.20 Mc INL	82.41	6.95	7	138	24.6	0.08	0.48	12.47
6/2/2005 22:35	44.7255	112.4875	1.50 Mc INL	121.96	5.80	12	155	16.4	0.10	0.69	14.92
6/6/2005 14:06	43.7495	111.0223	1.50 Mc INL	142.29	11.87	7	237	50.6	0.14	1.00	1.13
6/6/2005 18:01	44.4902	114.2563	2.10 Mc INL	150.51	0.03	16	243	89.6	0.31	2.19	3.12
6/6/2005 21:46	44.8302	112.7820	2.00 Mc INL	131.30	5.27	22	189	5.3	0.10	1.18	1.09
6/6/2005 22:52	44.8188	112.8035	1.20 Mc INL	130.04	5.25	6	201	3.7	0.03	9.30	8.58
6/6/2005 23:30	44.8400	112.8115	1.00 Mc INL	132.41	7.51	4	243	3.2	0.01	2.41	1.80
6/8/2005 18:11	44.2803	114.4998	1.40 Mc INL	154.53	0.11	10	250	80.1	0.26	2.60	2.33
6/9/2005 20:24	42.6885	111.6282	1.80 Mc INL	142.30	2.50	20	80	44.1	0.12	0.64	15.22
6/11/2005 0:19	44.0900	113.9495	2.00 Mc INL	105.73	0.02	21	193	43.7	0.09	0.59	1.69
6/11/2005 14:00	44.7827	111.5315	1.90 Mc INL	160.84	11.29	21	179	12.1	0.06	0.35	0.56
6/12/2005 8:40	44.0852	113.9583	1.50 Mc INL	106.12	6.16	10	194	50.8	0.15	0.77	2.32
6/14/2005 11:28	44.4272	114.4098	1.40 Mc INL	156.40	1.73	11	250	81.1	0.27	1.24	3.64
6/15/2005 9:06	44.2283	114.1623	1.50 Mc INL	128.02	6.53	14	222	61.1	0.23	0.79	2.47
6/15/2005 23:07	44.0835	113.9495	1.30 Mc INL	105.40	7.09	14	193	43.5	0.20	1.50	9.21
6/16/2005 7:13	44.4720	114.0683	1.30 Mc INL	137.68	1.52	14	231	55.8	0.13	0.78	1.47
6/18/2005 2:04	44.4017	114.4135	1.50 Mc INL	155.12	3.93	8	249	93.2	0.35	1.43	3.54
6/18/2005 20:32	44.2550	114.3565	1.50 Mc INL	143.06	5.24	11	238	77.0	0.28	2.68	4.50
6/19/2005 10:16	44.1298	114.5187	1.60 Mc INL	149.27	0.09	10	248	63.7	0.14	2.24	2.12
6/19/2005 18:20	44.2138	114.0343	1.80 Mc INL	118.40	0.05	21	210	51.4	0.21	1.02	1.53
6/22/2005 10:15	44.3828	114.4103	1.30 Mc INL	153.80	6.17	8	248	91.1	0.26	1.47	3.26
6/22/2005 13:28	44.7587	112.7743	2.10 Mc INL	123.35	8.14	26	128	9.7	0.07	0.61	1.90
6/22/2005 17:31	44.6940	112.4768	1.10 Mc INL	118.70	16.31	12	212	13.0	0.08	0.69	0.79
6/24/2005 17:42	43.7523	111.0613	1.60 Mc INL	139.18	8.76	13	216	49.6	0.12	0.77	1.09
6/25/2005 0:49	43.7672	111.1190	1.00 Mc INL	134.68	0.05	6	319	47.3	0.07	3.62	5.04
6/26/2005 9:14	44.5635	112.2068	1.50 Mc INL	111.60	4.45	9	125	15.3	0.09	0.35	0.65
6/26/2005 9:52	44.8695	113.2065	1.10 Mc INL	139.82	1.08	6	299	28.6	0.10	8.13	9.59
6/26/2005 13:01	44.6205	112.5515	1.00 Mc INL	109.55	2.33	4	239	12.8	0.30	12.60	23.91
6/27/2005 4:21	43.8497	114.3410	1.60 Mc INL	127.37	1.57	9	279	32.3	0.14	5.51	6.00
6/29/2005 17:00	44.3113	114.3420	1.80 Mc INL	145.06	11.01	8	239	83.0	0.14	1.12	2.47

Table D-2. Continued.

ORIGIN TIME	LAT N	LONG W	MAG -TYPE	DIST	Z	NO	GAP	DMIN	RMS	ERH	ERZ
6/29/2005 18:47	44.6222	112.5150	3.20 ML MB	110.26	9.15	33	128	10.1	0.06	0.19	0.72
6/29/2005 21:07	44.5920	112.5567	1.20 Mc INL	106.35	3.22	5	231	35.0	0.28	9.14	20.08
6/29/2005 21:24	44.6118	112.4848	1.00 Mc INL	109.63	5.16	4	155	7.5	0.04	8.39	9.80
6/30/2005 22:46	44.6298	112.4823	1.20 Mc INL	111.62	12.44	9	172	8.1	0.07	1.29	1.36
7/1/2005 15:27	44.4455	112.9030	1.00 Mc INL	89.02	4.65	3	321	13.3	0.06	7.49	6.57
7/3/2005 7:17	44.6190	112.5468	1.70 Mc INL	109.44	3.56	12	124	12.4	0.16	0.45	0.68
7/4/2005 5:55	42.6367	111.4435	2.10 Mc INL	156.75	0.03	32	105	31.5	0.15	0.33	1.03
7/4/2005 22:40	44.3767	114.0252	2.10 Mc INL	128.25	1.85	27	222	50.0	0.33	1.11	3.62
7/5/2005 14:20	44.3720	114.0168	0.00 Multiple	127.40	5.00	7	220	49.2	0.19	2.31	20.25
7/5/2005 20:34	44.7787	112.4725	0.90 Mc INL	128.00	0.00	6	242	21.5	0.25	3.95	3.09
7/6/2005 4:53	44.3587	114.0147	1.10 Mc INL	126.35	6.79	8	220	65.7	0.34	1.60	4.40
7/10/2005 11:55	44.6120	112.1023	0.80 Mc INL	120.08	4.25	5	136	23.3	0.14	0.76	1.48
7/11/2005 3:31	44.4758	112.1017	1.20 Mc INL	106.85	5.81	5	262	62.6	0.14	1.40	17.03
7/12/2005 9:22	44.7500	112.7675	0.90 Mc INL	122.38	4.43	5	210	10.8	0.06	5.62	11.58
7/12/2005 19:50	44.7223	111.8353	1.40 Mc INL	141.30	7.92	6	167	13.5	0.10	0.90	3.36
7/14/2005 5:30	44.5908	112.0760	1.30 Mc INL	118.97	17.42	8	168	25.3	0.31	1.49	1.04
7/16/2005 4:12	44.6355	111.9005	1.20 Mc INL	130.39	6.61	8	133	21.4	0.23	0.92	18.09
7/16/2005 4:16	44.6222	111.9052	1.50 Mc INL	128.95	14.06	9	129	22.5	0.13	1.21	2.42
7/16/2005 9:46	44.6890	111.7858	0.60 Mc INL	140.41	4.74	3	196	10.5	0.15	7.73	14.46
7/16/2005 20:55	44.6417	112.5358	0.60 Mc INL	112.08	4.64	3	165	12.4	0.03	4.87	9.64
7/20/2005 1:18	43.0537	111.4682	1.90 Mc INL	125.51	26.88	5	294	68.8	0.05	2.34	1.25
7/20/2005 2:45	44.0113	110.8757	2.00 Mc INL	158.51	0.15	21	208	31.6	0.09	0.58	1.01
7/20/2005 13:37	44.3198	112.7982	0.60 Mc INL	74.53	8.18	6	162	11.5	0.17	0.80	2.72
7/22/2005 2:10	44.3652	112.9407	0.70 Mc INL	80.56	10.89	4	284	4.0	0.00	2.47	1.72
7/22/2005 2:54	43.8157	110.8627	1.90 Mc INL	155.73	11.76	21	202	48.9	0.04	0.57	0.74
7/25/2005 12:30	43.5447	113.7765	0.80 Mc INL	81.03	6.87	8	270	17.4	0.14	1.66	3.96
7/26/2005 11:12	44.6728	111.9310	0.80 Mc INL	132.62	5.64	11	149	22.0	0.23	0.82	3.00
7/27/2005 2:25	45.0385	112.4393	0.00 Mc INL	156.88	2.27	7	244	39.9	0.26	7.66	3.54
7/28/2005 3:22	44.3770	111.0723	1.20 Mc INL	159.18	10.88	18	111	22.5	0.09	0.35	1.12
7/28/2005 8:09	44.3752	111.0650	1.40 Mc INL	159.59	7.62	17	113	22.6	0.11	0.38	1.51
7/28/2005 14:07	44.7262	112.8372	0.80 Mc INL	119.81	5.20	6	173	11.3	0.03	5.02	11.54
7/28/2005 14:40	43.7990	111.1035	1.80 Mc INL	136.27	11.76	17	171	43.9	0.13	0.59	0.76
7/28/2005 23:25	44.2005	113.9937	1.30 Mc INL	114.87	13.76	9	206	52.9	0.21	1.19	1.41
7/29/2005 16:38	44.9732	112.1815	1.40 Mc INL	154.82	6.59	12	209	45.4	0.29	1.25	23.40
7/30/2005 4:41	44.4310	112.5990	1.10 Mc INL	88.13	3.97	4	153	24.3	0.12	4.38	14.05
7/30/2005 6:37	43.2937	111.2742	1.70 Mc INL	128.30	5.46	12	178	27.8	0.23	0.67	1.28
7/30/2005 7:13	43.2885	111.2650	1.80 Mc INL	129.19	2.51	6	181	27.5	0.19	0.83	19.55
7/30/2005 7:19	43.2843	111.2785	1.70 Mc INL	128.31	6.81	24	92	26.7	0.17	0.46	0.84
7/30/2005 17:43	44.0258	110.8508	0.70 Mc INL	160.84	2.49	4	298	27.5	0.22	1.85	21.33
7/30/2005 17:51	44.0213	110.8538	1.40 Mc INL	160.49	2.77	10	298	28.0	0.12	1.04	14.39
7/31/2005 16:00	44.2082	114.0675	1.30 Mc INL	120.35	6.61	11	213	54.1	0.08	0.67	2.87
7/31/2005 18:46	44.3493	113.9758	1.60 Mc INL	123.27	6.82	14	216	45.7	0.24	1.14	3.93
8/1/2005 22:42	44.4020	114.1332	1.20 Mc INL	136.76	6.74	9	230	58.9	0.34	1.87	6.24
8/2/2005 12:01	44.2300	114.0142	1.50 Mc INL	118.00	8.18	6	209	56.1	0.19	1.95	4.71
8/2/2005 13:59	44.0332	110.8708	0.70 Mc INL	159.50	5.04	3	295	26.9	0.02	1.28	9.08
8/4/2005 1:08	44.2423	114.1413	1.50 Mc INL	127.36	10.13	7	295	65.3	0.24	1.62	2.67

Table D-2. Continued.

ORIGIN TIME	LAT N	LONG W	MAG-TYPE	DIST	Z	NO	GAP	DMIN	RMS	ERH	ERZ
8/4/2005 7:36	43.7547	111.1227	1.40 Mc INL	134.27	2.76	7	241	48.6	0.12	1.31	4.93
8/5/2005 11:24	44.2347	114.0357	1.00 Mc INL	119.73	3.12	5	289	51.0	0.13	5.70	10.66
8/5/2005 13:20	44.2048	113.9163	1.60 Mc INL	109.92	0.03	14	248	42.5	0.21	2.56	3.58
8/6/2005 17:33	43.7698	111.0837	1.50 Mc INL	137.54	6.65	10	260	84.9	0.27	1.86	1.54
8/8/2005 6:44	44.2633	114.0600	2.00 Mc INL	123.09	0.08	15	259	52.5	0.25	3.38	4.64
8/8/2005 8:28	43.6122	111.2112	2.10 Mc INL	126.85	11.80	28	151	63.4	0.27	0.53	0.84
8/8/2005 22:05	42.7403	111.4040	1.50 Mc INL	150.97	64.46	7	135	25.0	0.10	1.41	2.45
8/9/2005 3:35	42.8738	111.1360	1.10 Mc INL	159.13	2.09	9	209	12.4	0.09	1.57	14.00
8/11/2005 7:23	44.5970	112.5187	1.60 Mc INL	107.46	4.33	12	211	9.9	0.14	1.04	1.20
8/11/2005 15:30	42.7983	111.2500	0.90 Mc INL	156.44	2.60	9	211	12.8	0.10	1.61	13.96
8/12/2005 17:47	44.7647	111.5143	1.00 Mc INL	160.15	12.42	7	175	12.6	0.06	0.49	1.46
8/14/2005 13:54	44.3715	114.0052	1.70 Mc INL	126.64	7.13	11	220	48.3	0.28	1.51	4.05
8/15/2005 1:07	44.7485	111.7217	2.10 Mc INL	148.74	0.05	26	171	27.1	0.17	0.40	0.87
8/15/2005 7:14	43.7358	113.8900	1.30 Mc INL	89.71	7.28	13	172	35.6	0.28	0.80	24.50
8/15/2005 21:13	42.8302	111.3893	1.40 Mc INL	145.32	2.57	5	215	12.3	0.15	1.52	15.76
8/15/2005 22:31	43.7663	111.0847	1.50 Mc INL	137.42	8.50	6	213	47.8	0.05	0.96	1.97
8/15/2005 22:57	44.2898	114.4030	1.60 Mc INL	148.15	0.03	9	242	80.8	0.15	2.39	1.42
8/15/2005 23:06	44.7667	111.5282	1.30 Mc INL	159.63	6.41	6	175	41.3	0.10	0.68	14.74
8/16/2005 11:39	44.3765	113.9967	2.00 Mc INL	126.47	0.01	18	258	47.7	0.21	1.60	2.02
8/18/2005 3:53	44.3365	113.9892	1.30 Mc INL	123.23	7.41	7	216	62.5	0.34	1.90	30.63
8/20/2005 19:49	44.6085	112.5202	1.30 Mc INL	108.69	2.44	5	145	10.1	0.15	7.50	14.57
8/22/2005 2:16	44.0893	114.5127	1.80 Mc INL	147.31	5.97	5	246	59.2	0.02	5.15	6.66
8/22/2005 9:58	44.7810	112.3540	1.70 Mc INL	130.41	15.78	21	172	21.1	0.10	0.45	0.54
8/23/2005 1:44	44.3277	114.0530	1.20 Mc INL	126.70	7.64	7	220	65.4	0.20	1.22	3.25
8/24/2005 9:14	44.7587	112.8353	2.10 Mc INL	123.42	6.17	22	130	7.7	0.09	1.40	2.26
8/24/2005 9:29	44.7477	112.8327	1.80 Mc INL	122.19	3.55	19	128	9.0	0.07	0.81	1.88
8/24/2005 21:53	44.2435	114.6063	1.40 Mc INL	160.50	0.04	9	257	77.4	0.30	5.53	16.19
8/25/2005 13:42	44.7523	112.3772	0.80 Mc INL	126.85	16.74	6	262	17.7	0.01	2.83	0.91
8/26/2005 1:54	42.7003	111.7800	1.40 Mc INL	133.44	4.99	5	150	51.6	0.27	1.35	20.91
8/26/2005 5:18	43.1703	111.3418	1.80 Mc INL	128.30	2.19	23	223	13.2	0.08	0.95	10.27
8/26/2005 13:19	42.9325	111.2040	0.70 Mc INL	150.92	1.66	8	200	17.8	0.08	0.82	1.39
8/26/2005 14:57	42.9268	111.2062	1.70 Mc INL	151.11	10.61	32	197	17.6	0.08	0.47	0.55
8/26/2005 15:18	42.9382	111.2178	0.70 Mc INL	149.62	1.91	7	197	16.6	0.03	0.99	1.25
8/26/2005 16:34	43.7738	111.0917	1.60 Mc INL	136.93	11.45	16	174	46.9	0.25	1.07	1.48
8/26/2005 23:27	43.3735	110.9270	1.70 Mc INL	153.12	8.88	12	115	50.6	0.11	0.52	1.30
8/26/2005 23:59	43.7430	111.0573	1.90 Mc INL	139.43	6.31	16	113	50.7	0.12	0.71	1.16
8/27/2005 4:14	44.4812	112.1727	1.50 Mc INL	104.59	4.59	5	278	59.0	0.12	6.52	11.05
8/29/2005 14:01	44.6192	112.0872	1.50 Mc INL	121.34	9.25	8	147	24.6	0.08	0.72	3.42
8/29/2005 18:46	43.7230	111.0390	0.90 Mc INL	140.78	3.80	5	259	53.2	0.08	2.01	1.75
8/30/2005 19:29	43.8565	111.1267	1.70 Mc INL	135.29	10.85	22	164	37.4	0.16	0.49	1.31
8/30/2005 19:47	43.8663	111.1213	1.00 Mc INL	135.90	13.12	5	198	36.3	0.04	0.62	0.91
8/31/2005 5:52	43.0692	111.4078	1.80 Mc INL	128.80	4.90	24	176	3.5	0.06	0.97	0.78
9/4/2005 11:24	44.3358	113.9670	2.10 Mc INL	121.79	6.92	16	214	44.9	0.11	0.74	6.08
9/4/2005 16:17	42.6750	111.7108	1.20 Mc INL	139.14	5.00	7	108	50.4	0.26	0.66	18.50
9/5/2005 0:50	44.7515	112.8285	1.70 Mc INL	122.60	5.63	16	141	8.6	0.15	3.59	6.45
9/5/2005 4:05	43.7837	111.0642	1.60 Mc INL	139.24	11.97	13	196	46.2	0.21	0.88	0.96

Table D-2. Continued.

ORIGIN TIME	LAT N	LONG W	MAG -TYPE	DIST	Z	NO	GAP	DMIN	RMS	ERH	ERZ
9/7/2005 11:00	44.6053	112.1608	1.30 Mc INL	117.35	5.87	10	135	18.6	0.12	0.48	16.23
9/7/2005 21:31	44.2618	114.5415	1.70 Mc INL	156.63	0.13	7	312	90.9	0.25	9.26	4.85
9/8/2005 8:48	44.6017	112.1650	1.10 Mc INL	116.85	11.61	10	166	18.2	0.15	0.98	1.43
9/9/2005 17:06	44.2690	114.5787	1.80 Mc INL	159.66	0.02	12	256	79.7	0.30	2.82	3.75
9/12/2005 15:32	44.6483	114.1870	2.00 Mc INL	157.92	1.69	18	257	72.6	0.21	0.96	2.44
9/15/2005 19:36	42.7418	111.2918	1.10 Mc INL	157.75	9.11	9	128	15.9	0.05	0.89	3.63
9/18/2005 4:24	44.3568	113.2055	1.40 Mc INL	85.61	9.29	8	135	16.7	0.10	0.70	2.48
9/18/2005 6:33	44.0890	113.9060	0.90 Mc INL	102.59	0.12	7	284	40.5	0.28	6.32	5.73
9/18/2005 11:48	43.9487	113.8177	0.70 Mc INL	89.62	3.27	6	322	29.4	0.22	3.73	1.95
9/18/2005 17:33	44.2853	113.2263	0.40 Mc INL	79.12	7.06	8	117	14.5	0.31	1.14	20.48
9/20/2005 5:04	44.5018	112.9707	1.30 Mc INL	95.95	17.98	7	162	19.3	0.18	2.08	0.66
9/20/2005 19:27	44.3267	112.6872	0.90 Mc INL	75.67	1.88	5	98	20.3	0.11	0.61	4.27
9/21/2005 9:21	44.6480	111.9028	1.00 Mc INL	131.46	6.45	11	138	20.9	0.23	0.89	18.42
9/22/2005 6:57	44.0883	113.8940	1.50 Mc INL	101.71	0.14	14	244	39.6	0.21	1.32	2.60
9/22/2005 23:09	42.7752	111.2233	1.10 Mc INL	159.74	13.78	8	126	10.1	0.02	4.16	4.05
9/28/2005 0:04	44.3233	112.6810	0.90 Mc INL	75.35	1.34	7	174	20.8	0.21	0.85	1.96
9/28/2005 4:57	44.1622	113.9200	1.30 Mc INL	107.62	7.01	9	284	44.3	0.29	1.79	12.92
9/28/2005 23:06	42.7392	111.2903	1.20 Mc INL	158.03	7.85	9	97	15.8	0.06	0.81	2.50
9/28/2005 23:45	44.2180	113.9830	1.30 Mc INL	115.18	0.08	11	253	47.3	0.24	3.73	4.89
9/29/2005 17:29	44.7697	112.3725	1.70 Mc INL	128.81	15.58	16	170	19.7	0.17	0.56	0.60
9/29/2005 18:12	44.3298	114.4868	1.40 Mc INL	156.14	0.03	12	294	86.3	0.20	3.12	4.87
9/30/2005 2:49	44.4072	112.5790	1.30 Mc INL	85.81	5.23	8	158	25.4	0.28	1.08	2.73
10/1/2005 22:30	42.7350	111.3680	1.60 Mc INL	153.55	2.65	8	138	22.2	0.32	1.51	29.19
10/2/2005 11:47	44.1103	114.0005	1.60 Mc INL	110.39	6.65	16	253	48.4	0.32	2.55	5.46
10/4/2005 21:08	42.7463	111.6002	1.10 Mc INL	139.07	5.03	3	302	25.8	0.05	2.38	11.86
10/5/2005 1:34	44.6152	112.5332	1.40 Mc INL	109.22	4.97	8	148	11.3	0.17	1.89	3.40
10/6/2005 21:59	44.1572	113.2172	1.70 Mc INL	66.33	18.51	4	306	25.1	0.00	8.32	2.99
10/7/2005 15:07	44.3718	112.5367	0.90 Mc INL	82.69	0.03	4	199	17.8	0.06	1.08	4.02
10/7/2005 15:08	44.4140	112.4512	0.80 Mc INL	89.06	20.32	4	230	13.4	0.19	2.34	3.65
10/7/2005 17:16	42.7853	111.4797	0.90 Mc INL	143.02	0.03	12	77	17.6	0.09	0.32	1.07
10/7/2005 22:15	44.6215	112.5167	0.80 Mc INL	110.16	3.08	5	155	10.2	0.13	7.43	12.70
10/8/2005 16:28	44.8505	112.2932	0.90 Mc INL	139.16	15.14	3	289	29.7	0.00	2.62	1.75
10/8/2005 18:18	42.5483	111.6067	0.70 Mc INL	155.50	2.50	7	95	48.0	0.27	0.77	25.45
10/9/2005 18:14	44.2343	114.5842	1.70 Mc INL	158.48	0.16	5	313	96.8	0.24	11.27	10.67
10/10/2005 23:05	42.7448	111.3167	1.60 Mc INL	155.98	2.52	9	93	17.9	0.25	0.91	23.60
10/11/2005 1:29	44.6563	112.1463	1.00 Mc INL	122.98	14.00	10	180	20.9	0.22	0.64	1.53
10/11/2005 11:36	44.1638	113.9923	1.00 Mc INL	112.67	7.72	7	223	49.7	0.07	0.89	13.77
10/12/2005 10:28	43.0443	111.4243	0.80 Mc INL	129.09	0.02	6	179	4.5	0.12	0.62	1.06
10/12/2005 21:17	42.7995	111.4648	1.10 Mc INL	142.86	7.88	6	275	15.8	0.11	1.76	4.03
10/13/2005 10:54	44.0260	114.4392	1.50 Mc INL	139.55	7.05	11	251	51.6	0.15	1.25	3.90
10/13/2005 15:10	44.4697	112.0753	0.90 Mc INL	107.37	17.78	4	286	24.0	0.06	2.39	0.60
10/16/2005 3:17	44.1988	113.1102	1.10 Mc INL	66.46	7.09	7	179	19.8	0.27	1.02	20.81
10/17/2005 6:07	42.8893	111.2545	1.00 Mc INL	150.15	2.04	10	164	14.7	0.13	0.63	13.16
10/17/2005 22:41	44.2770	114.5615	1.70 Mc INL	158.80	0.02	13	254	80.4	0.33	2.73	3.91
10/18/2005 10:32	44.4208	112.5418	1.20 Mc INL	87.90	2.72	6	131	20.0	0.16	0.58	1.58
10/19/2005 20:30	44.5503	112.7398	0.90 Mc INL	100.22	11.47	9	125	27.9	0.11	0.62	3.31

Table D-2. Continued.

ORIGIN TIME	LAT N	LONG W	MAG -TYPE		DIST	Z	NO	GAP	DMIN	RMS	ERH	ERZ
10/19/2005 20:45	44.4095	113.9135	1.40	Mc INL	123.87	7.36	10	217	42.0	0.30	1.23	25.71
10/21/2005 7:25	43.9748	114.3743	1.70	Mc INL	132.97	6.49	14	239	45.9	0.28	1.29	2.92
10/21/2005 10:27	44.4910	112.0793	1.40	Mc INL	109.22	12.46	14	108	25.2	0.20	0.47	1.61
10/24/2005 23:12	44.2387	114.5417	1.10	Mc INL	155.57	0.02	6	252	75.9	0.07	4.15	2.63
10/24/2005 23:57	42.7822	111.4862	0.80	Mc INL	142.87	2.81	10	106	18.1	0.14	0.45	14.51
10/26/2005 22:12	44.2662	114.5683	1.70	Mc INL	158.78	0.04	12	254	79.3	0.29	2.74	4.61
10/27/2005 17:40	44.7210	111.7673	1.30	Mc INL	144.17	8.20	5	164	8.1	0.17	0.97	3.46
10/28/2005 0:10	44.6568	112.5523	0.80	Mc INL	113.52	4.75	4	284	14.4	0.12	8.35	12.02
10/30/2005 2:22	44.6087	112.1037	1.60	Mc INL	119.70	5.97	11	135	37.3	0.22	0.61	22.04
10/30/2005 3:14	44.5215	113.3965	1.30	Mc INL	108.68	5.30	5	227	23.4	0.13	1.23	1.99
10/30/2005 14:48	44.1220	113.9715	1.80	Mc INL	108.95	2.74	13	198	46.9	0.28	1.22	3.10
10/30/2005 16:59	44.1473	113.9603	1.70	Mc INL	109.54	5.02	11	217	47.4	0.15	1.40	17.83
10/30/2005 22:59	44.1130	113.9277	1.40	Mc INL	105.39	7.67	9	193	43.3	0.34	1.24	7.17
10/31/2005 0:23	44.8592	113.4240	4.60	Mw US	143.93	0.59	25	272	45.6	0.13	2.40	2.41
11/1/2005 5:52	44.8110	113.3623	1.20	Mc INL	137.20	7.14	8	262	40.7	0.06	1.58	12.31
11/5/2005 9:03	44.2570	114.0557	1.40	Mc INL	122.42	6.91	12	215	52.3	0.27	1.39	4.30
11/8/2005 5:14	44.6173	112.5315	1.90	Mc INL	109.48	4.73	22	125	11.2	0.20	0.56	0.76
11/9/2005 7:32	43.8915	112.9767	0.60	Mc INL	31.06	1.99	6	123	10.4	0.08	0.57	12.86
11/9/2005 21:35	44.3867	113.9775	2.00	Mc INL	126.02	0.10	20	257	46.4	0.15	1.48	2.54
11/12/2005 9:58	44.6180	112.5203	1.70	Mc INL	109.72	6.46	18	127	10.4	0.11	0.49	1.59
11/13/2005 6:46	44.3425	113.9552	1.70	Mc INL	121.52	6.99	19	215	44.0	0.34	1.08	2.83
11/14/2005 14:32	44.3727	114.0148	1.60	Mc INL	127.32	9.40	13	220	49.1	0.29	1.15	2.20
11/14/2005 20:02	44.3488	114.0218	1.20	Mc INL	126.12	6.91	8	219	49.4	0.28	1.48	5.29
11/14/2005 20:51	44.5578	112.5150	1.10	Mc INL	103.25	13.35	7	131	10.4	0.20	1.03	2.21
11/16/2005 23:00	44.6138	112.5258	1.70	Mc INL	109.18	6.70	20	125	10.7	0.15	0.48	1.43
11/17/2005 6:47	44.2545	114.2253	1.10	Mc INL	133.84	0.76	9	253	65.8	0.21	4.35	4.30
11/18/2005 13:36	44.5520	112.4640	0.80	Mc INL	103.54	12.16	6	223	7.2	0.29	2.80	1.35
11/20/2005 22:52	44.3037	112.5960	0.80	Mc INL	74.25	1.51	11	97	22.6	0.27	0.63	2.07
11/21/2005 17:50	44.7708	111.5243	3.10	ML US	160.17	11.13	33	177	12.1	0.16	0.52	1.32
11/21/2005 17:52	44.7925	111.5037	3.70	ML US	161.73	11.53	32	181	12.8	0.14	0.61	0.83
11/21/2005 17:56	44.7748	111.5210	1.20	Mc INL	160.68	13.25	10	197	12.5	0.12	0.79	1.21
11/21/2005 18:07	44.7647	111.5215	1.90	Mc INL	159.79	12.44	17	175	12.1	0.08	0.38	0.78
11/21/2005 18:14	44.7677	111.5172	0.60	Mc INL	160.27	12.67	5	176	12.5	0.11	0.70	1.36
11/21/2005 18:18	44.7707	111.5190	1.60	Mc INL	160.43	11.61	15	177	12.5	0.08	0.42	1.01
11/21/2005 19:40	44.7678	111.5168	0.40	Mc INL	160.29	13.01	5	176	12.5	0.06	0.58	1.34
11/21/2005 19:45	44.7675	111.5270	0.30	Mc INL	159.76	14.20	4	201	11.7	0.04	1.12	2.34
11/22/2005 0:22	44.7605	111.5078	0.70	Mc INL	160.13	6.10	10	194	13.0	0.11	0.58	7.28
11/22/2005 21:12	44.2207	114.0147	0.80	Mc INL	117.48	7.07	8	209	49.7	0.29	1.55	9.10
11/22/2005 22:36	44.7092	111.5733	2.10	Mc INL	152.42	6.95	20	280	71.9	0.11	1.57	1.00
11/22/2005 22:51	44.7408	111.4862	0.60	Mc INL	159.57	5.00	3	180	14.3	0.19	10.64	13.35
11/23/2005 1:48	44.7682	111.5150	1.40	Mc INL	160.42	9.25	18	176	12.7	0.14	0.50	1.88
11/23/2005 2:03	44.7743	111.5237	0.70	Mc INL	160.51	14.99	6	178	12.3	0.09	0.62	1.02
11/23/2005 2:52	43.3228	111.0267	2.10	Mc INL	146.60	10.00	29	193	41.0	0.25	0.51	1.06
11/23/2005 10:34	44.7685	111.5202	0.80	Mc INL	160.18	13.57	5	176	12.3	0.04	0.49	0.80
11/23/2005 13:15	44.7603	111.5108	1.30	Mc INL	159.96	12.44	11	174	12.7	0.12	0.58	0.93
11/23/2005 21:27	44.7673	111.5202	0.90	Mc INL	160.08	13.93	7	176	12.2	0.07	0.48	0.76

Table D-2. Continued.

ORIGIN TIME	LAT N	LONG W	MAG -TYPE	DIST	Z	NO	GAP	DMIN	RMS	ERH	ERZ
11/23/2005 22:36	42.7447	111.2762	1.10 Mc INL	158.51	12.26	9	132	14.6	0.18	2.51	2.75
11/25/2005 3:40	44.7638	111.5208	1.50 Mc INL	159.75	9.65	18	194	12.1	0.10	0.38	0.86
11/27/2005 13:32	44.7040	111.9372	1.60 Mc INL	135.35	12.89	13	160	21.7	0.20	0.84	1.83
11/27/2005 13:34	44.7337	111.9360	1.20 Mc INL	138.26	14.52	10	168	21.4	0.16	1.10	1.08
11/28/2005 10:08	44.7670	111.5127	0.90 Mc INL	160.43	8.64	7	176	12.8	0.08	0.56	2.69
11/29/2005 8:22	44.6977	111.9275	1.50 Mc INL	135.13	0.03	10	207	31.8	0.24	0.96	1.69
11/29/2005 16:30	44.2557	114.3493	1.50 Mc INL	142.59	0.55	9	237	77.2	0.13	1.80	2.54
11/29/2005 17:08	44.6308	111.9867	1.60 Mc INL	126.34	4.48	8	137	27.7	0.22	0.73	2.67
11/30/2005 6:41	44.7728	111.5222	1.70 Mc INL	160.45	9.19	16	196	12.3	0.19	0.63	1.45
12/1/2005 18:50	43.6482	113.8567	1.10 Mc INL	86.58	1.48	9	147	29.7	0.20	0.63	1.97
12/2/2005 6:28	44.7565	111.5148	0.90 Mc INL	159.43	11.79	6	174	12.3	0.04	0.56	0.84
12/2/2005 22:36	44.2797	114.5868	1.70 Mc INL	160.75	0.02	13	256	81.0	0.32	3.02	3.13
12/6/2005 12:17	44.7617	111.5165	1.80 Mc INL	159.79	10.81	17	194	12.3	0.06	0.42	0.96
12/7/2005 3:31	44.7097	111.7968	1.30 Mc INL	141.81	10.08	10	157	10.6	0.14	0.80	1.47
12/9/2005 5:04	44.4478	112.6667	0.90 Mc INL	89.24	5.87	12	129	25.5	0.13	0.93	1.69
12/13/2005 5:42	44.2173	114.0278	0.80 Mc INL	118.17	4.90	5	313	50.8	0.09	5.50	12.03
12/14/2005 11:28	44.6973	111.9428	1.00 Mc INL	134.48	5.13	6	158	22.3	0.12	2.59	3.08
12/15/2005 19:59	44.6140	111.8678	1.20 Mc INL	129.85	17.49	5	181	20.6	0.10	1.56	0.80
12/17/2005 6:19	44.3933	112.9520	0.70 Mc INL	83.79	10.86	7	250	7.2	0.17	1.24	2.39
12/17/2005 8:59	44.4948	113.1093	1.70 Mc INL	97.55	4.31	19	234	22.8	0.20	0.67	0.68
12/18/2005 5:46	44.6020	112.2613	0.90 Mc INL	113.84	12.11	5	270	10.6	0.01	3.05	1.32
12/20/2005 14:21	44.4782	114.2372	1.90 Mc INL	148.49	4.75	12	242	68.8	0.28	1.54	5.64
12/21/2005 11:53	44.6835	111.9510	1.50 Mc INL	132.83	2.38	13	153	23.2	0.28	0.99	2.03
12/21/2005 13:23	44.7605	111.5082	1.10 Mc INL	160.10	10.34	10	174	12.9	0.07	0.42	1.15
12/21/2005 21:07	44.2572	114.5565	2.00 Mc INL	157.50	0.04	14	253	78.1	0.30	2.88	2.43
12/22/2005 2:00	44.5765	114.1060	2.00 Mc INL	147.75	0.16	12	240	89.0	0.20	2.05	2.64
12/22/2005 19:50	44.5620	112.3483	2.20 Mc INL	107.26	6.84	20	116	5.1	0.14	0.35	1.18
12/24/2005 17:27	44.7705	112.4448	1.50 Mc INL	127.55	14.30	11	168	20.1	0.12	0.77	0.93
12/26/2005 1:56	44.9383	113.6900	1.50 Mc INL	160.55	0.04	13	259	67.6	0.36	5.34	5.14
12/26/2005 4:20	44.3318	112.7572	1.30 Mc INL	75.88	9.60	17	135	14.7	0.16	0.48	2.08
12/26/2005 20:39	44.3868	112.5368	1.00 Mc INL	84.31	1.71	6	164	18.2	0.28	0.84	2.80
12/26/2005 20:41	44.3538	112.2313	0.90 Mc INL	89.92	31.40	5	312	7.0	0.06	2.18	0.82
12/27/2005 0:10	43.0308	111.4280	1.50 Mc INL	129.64	4.73	16	129	39.8	0.31	0.70	1.77
12/27/2005 12:49	44.8120	113.3587	1.60 Mc INL	137.20	6.98	8	262	40.4	0.07	1.56	13.97
12/29/2005 1:27	43.9455	114.3013	1.40 Mc INL	126.48	1.43	9	278	68.2	0.31	5.70	7.47
12/31/2005 16:39	44.7707	111.5140	1.40 Mc INL	160.68	9.34	15	201	12.8	0.09	0.44	1.27