2.

SEISMOGRAPH STATIONS IN HUNGARY

In 2000, there has been no significant changes with the Hungarian earthquake monitoring network compared to the previous year, one new digital three component short period seismograph station has been installed at Etyek.

The micro-seismic monitoring network established by the *Paks Nuclear Power Plant Ltd.* in 1995, has been operational throughout the year. In 1999, the network has been slightly reconfigured and extended (*Üveghuta network*) to monitor micro-seismic activity at a potential nuclear waste disposal site vicinity.

In addition to the information from the 12 station *Paks* and *Üveghuta* micro-seismic monitoring network, data is contributed by 5 stations operated by the *Seismological Observatory, GGKI.* Of those, one belongs to the *Ministry of Foreign Affairs* and is operated in cooperation with the German GEOFON network.

Data interchange with stations from the neighboring countries and international data centers was also important.

The estimated detection capabilities of the present network with average noise conditions, supposing that at least four stations is needed for origin determination, is typically around 1.5-2.0 ML, somewhat lower in the middle of the country and a little higher towards the border regions. (See Fig. 2.4) This means that in most parts of the country it is very unlikely that felt events go undetected.

During the reporting period, we also had access to six strong motion accelerograph stations belonging to and operated by different organizations such as *Paks Nuclear Power Plant, GeoRisk, GGKI, Ministry of Environment* and *MOL RT.*

Seismograph Stations

Table 2.1.
Seismic stations, instrumentation and lithology

Code	Latitude (N)	Longitude (E)	Elevation (m)	Foundation	Type of station (1)	Sensor type (2)	Recording (3)	Org. (4)
BUD	47,4836	19,0239	196	dolomite	3C LP	Kirnos	A - C	GGKI
BUDA	47,4836	19,0239	196	dolomite	3C SP	LE-3D	D - E	GR
ETYK*	47.4404	18.7449	250	marl	3C SP	SS-1	D - E	GGKI
GYL	46,5981	21,1718	92	sand	3C SP	SS-1	D - E	GGKI
PENC	47,7905	19,2817	250	alluvium	3C SP	LE-3D	D - E	GGKI
PKS2	46,4920	19,2131	106	sand	3C SP	LE-3D	D - E	GR
PKS6	46,5998	19,5645	120	sand	3C SP	LE-3D	D - E	GR
PKS7	47,0473	19,1609	95	mud	3C SP	LE-3D	D - E	GR
PKS8	46,8787	18,6765	135	rhyolite tuff	3C SP	LE-3D	D - E	GR
PKS9	46,5870	18,2789	240	loess	3C SP	LE-3D	D - E	GR
PKSc	47,3806	18,4371	200	dolomite	3C SP	LE-3D	D - E	GR
PKSm	46,2119	18,6413	170	granite	3C SP	LE-3D	D - E	GR
PKSn	46,8972	19,8673	110	sand	3C SP	LE-3D	D - E	GR
PSZ	47,9184	19,8944	940	andesite	3C BB	STS-2	D - C	GGKI
RHK1	46,0948	18,0720	297	limestone	3C SP	LE-3D	D - E	GGKI-GR
RHK2	46,1270	18,7799	147	loess	3C SP	LE-3D	D - E	GGKI-GR
RHK3	45,8885	18,2521	420	limestone	3C SP	LE-3D	D - E	GGKI-GR
SOP	47,6833	16,5583	260	gneiss	3C SP	SS-1	D - E	GGKI

(1) 1C - one component vertical seismometer, 3C - three component seismometer
SP - short period seismometer, BB - broad band seismometer, SM - strong motion accelerograph

(2) STS-2 - Streckeisen broad band seismometer, LE-3D - Lennartz three directional 1Hz geophone,
SS-1 - Kinemetrics 1Hz seismometer, Kirnos - 12 s long period seismometer

(3) A - analogue, D - digital, C - continuous recording, E - event recording

(4) GGKI - Geodetic and Geophysical Research Institute, GR - GeoRisk Ltd., PART - Paks Nuclear Power Plant Ltd.

(*) ETYK on date 2000/02/03

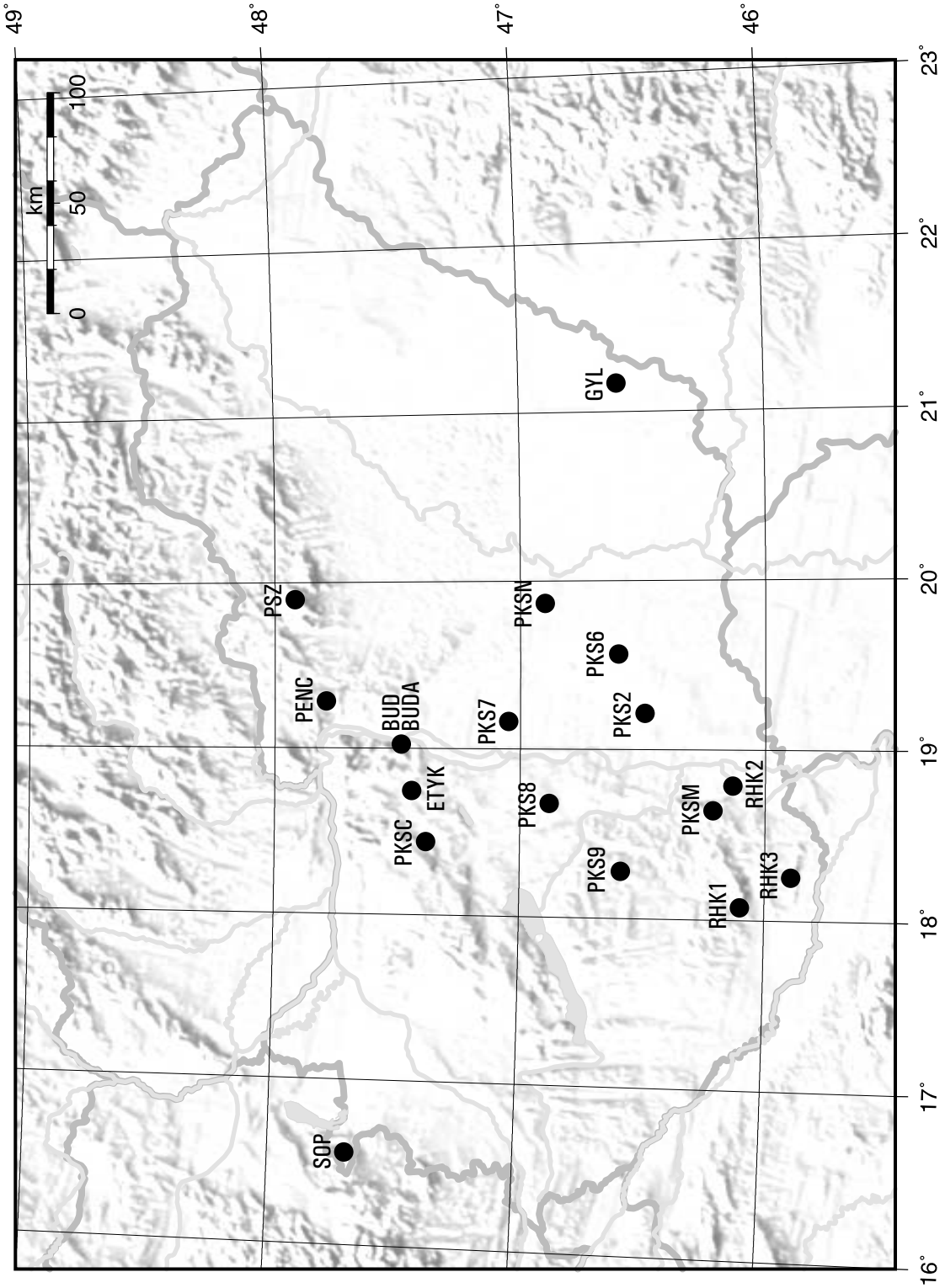

Figure 2.1.
Seismograph stations in Hungary
(See Table 2.1. for detailes)

Seismograph Stations

Table 2.2.
Strong motion accelerograph stations

Code	Latitude (N)	Longitude (E)	Elevation (m)	Foundation	Type of station (1)	Sensor type (2)	Recording (3)	Org. (4)
ALGY	46.3332	20.2092	90	loose sand	3C SM	AC-23	D - E	MO-GR
BOD	47.322	18.241	250	limestone	3C SM	AC-23	D - E	GR
BPGY	47.4836	19.0239	196	dolomite	3C SM	AC-23	D - E	GGKI
PAKB	46.5743	18.8587	100	sand	3C SM	AC-23	D - E	PART
PAKK	46.5743	18.8449	100	loose sand	3C SM	AC-23	D - E	GGKI
TLK	47.5500	18.8300	220	limestone	3C SM	AC-23	D - E	GGKI

(1) 3C - three component seismometer
SM - strong motion accelerograph

(2) AC-23 - triaxial accelerometer package (full scale 0.5g)

(3) D - digital, E - event recording

(4) GGKI - Geodetic and Geophysical Research Institute, GR - GeoRisk Ltd., MO – MOL Hungarian Oil Company Ltd.
PART - Paks Nuclear Power Plant Ltd.

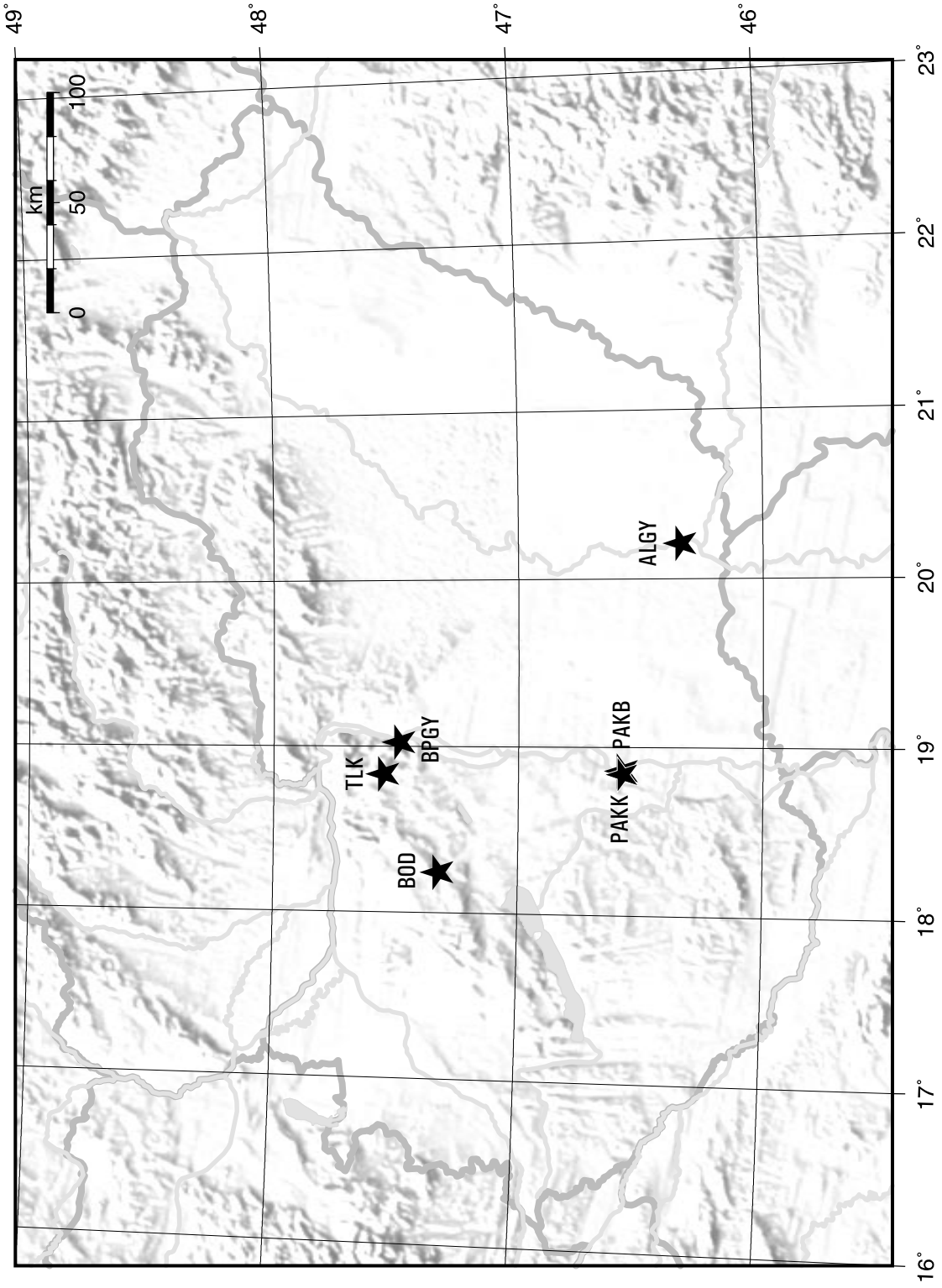

Figure 2.2.
Strong motion accelerograph stations in Hungary
(See Table 2.2. for detailes)

Seismograph Stations

PAKS MICRO-SEISMIC MONITORING NETWORK

The system comprises of a network of eight seismometer stations, located within a radius of about 100 km from the Power Plant at Paks (situated in the center of Hungary) and one additional station in Budapest where the data center is set up and collected data analyzed (Tóth and Mónus, 1997).

The field stations each consist of a three component short period seismometer located in a pit, with a digital recorder and time signal receiver housed nearby in a heat insulated steel container building.

The seismometers used are the LE-3D three directional compact size high sensitivity 1 Hz geophones. The digital acquisition system is the MARS-88 recorder that uses 20 bit AD converters sampling the data 62.5 times per second. The recorder also performs signal detection by its internal STA/LTA algorithm. The stations store event and continuous monitor channel data on rewritable magneto-optical disks, which are collected and transferred to the data center on a weekly basis. Most of the stations are powered by solar panels, and absolute time is provided by DCF-77 time code receivers.

At the data center a SUN workstation with sufficient on-line disk capacity serves as a powerful tool for the routine data processing and analysis. Lennartz M88 database software is used for the data management and XPITSA for advanced seismogram analysis. All recorded data are archived on CDs. Both waveform and bulletin data are available over the INTERNET for authorized remote users.

The *PAKS micro-seismic monitoring network* is currently operated and its data processed and analyzed by *GeoRisk Ltd.*

Extensive noise survey has been carried out at those station sites where magneto-optical disks storage allowed to store large amount of data. Noise segments of 3 minutes has been recorded with 11 hours shifts. Figure 2.3. shows the vertical components of the very long term averaged (near to one year) noise power spectra. There is a clear separation of the rocky sites (PKSm, PKSc and PKS8) from those of having loose sediments (PKSn, PKS2, PKS6, PKS7, PKS9).

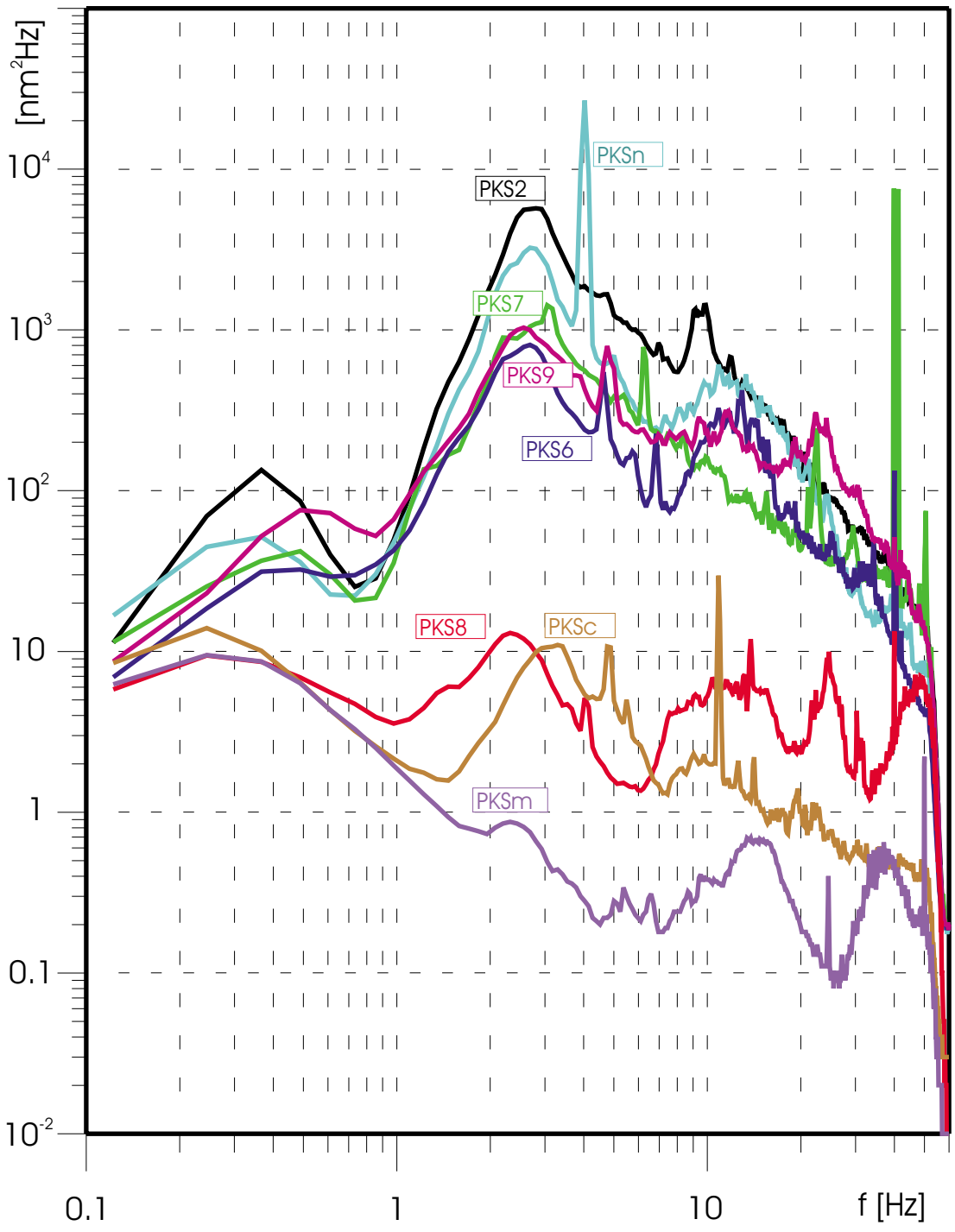

Figure 2.3.
Average noise power spectra for seismograph stations
(See text for detailes)

Seismograph Stations

ÜVEGHUTA MICRO-SEISMIC MONITORING NETWORK

Two relocated stations from the PAKS network and one additionally installed station forms the *Üveghuta micro-seismic monitoring network*.

The system comprises of a network of three seismometer stations, located in the potential nuclear waste disposal vicinity at Üveghuta (situated in southern part of Hungary).

The field stations hardware are just like the PAKS stations, each consist of a three component short period seismometer, with a digital recorder and time signal receiver housed in a nearby building.

The stations are accessible over commercial telephone lines. Event data are collected and transferred to the Budapest data center on a daily basis and analyzed jointly with the Paks network data.

The network is currently operated and its data processed and analyzed by *GGKI* and *GeoRisk Ltd.*

STATIONS OPERATED BY GGKI

During 2000 *GGKI* operated five digital and one analogue seismological stations.

Station *Piszkés (PSZ)* has been installed as an 'Open Station' under a cooperation between the Ministries for Foreign Affairs of Hungary and of Germany with the primary goal of nuclear test ban monitoring (Tóth, 1992). The station is equipped with a triaxial Streckeisen STS-2 broad-band seismometer and Quanterra's data acquisition system with a 24 bit, 80 Hz high resolution digitizer. Three component continuous data streams are recorded in circular buffers on magnetic disks and archived on tape cartridge. Continuous data is available on-line for more than a month. All data can be accessed directly and retrieved either in interactive or automatic mode. In 2000 PSZ also contributed data to GEOFON Project.

GYL and SOP are three component short period stations installed in 1994. Kinemetrics SSR-1 16bit digitizers and event recorders sample and record the output of three component SS-1 Ranger seismometers. Data of recorded events are collected via commercial telephone links.

A long period analogue recording seismograph has been operated at the *Seismological Observatory* in Budapest mostly for demonstration purposes.

STRONG MOTION STATIONS

Although the six strong motion accelerograph stations belong to three different organizations, they are all equipped with the same instrumentation: AC-23 triaxial accelerometer package (full scale 0.5g) and an SM-2 digital event recorder (manufactured by SIG^{SA}, Switzerland).

During 2000, we had access to all of these stations.

Seismograph Stations

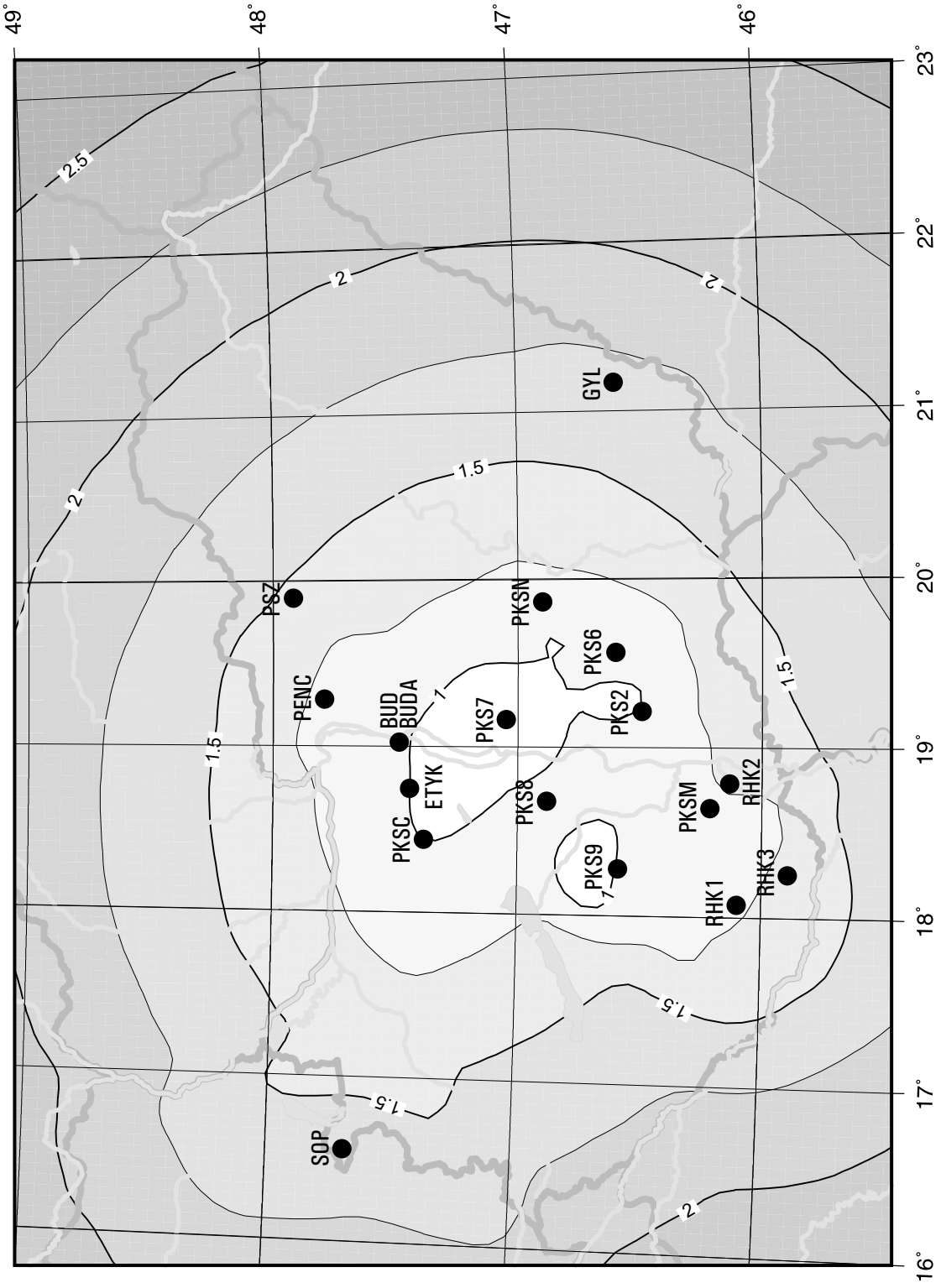

Figure 2.4.
Detection capability at average noise conditions.
Contour values are Richter local magnitudes (ML).