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INDEPTH-2
WIDE-ANGLE EXPERIMENT, TIBET 1994

Submitted By

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PASSCAL Data Report 96-013

IRIS DATA MANAGEMENT SYSTEM

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DATA FOR IRIS-PASSCAL ARCHIVES

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CONTENT:

SUMMERY:

The wide-angle component of project INDEPTH was designed to delineate the three-dimensional deep structure of the Tsangpo Suture, the India-Asia continental collision suture, an area of rugged topography where standard CMP profiling is technically not feasible. A Stanford University - Chinese MGMR team deployed 30 REFTEK stations (numbered 1 to 36; see map) for the five-months duration of the CMP experiment. These permanent stations were deployed, to provide inline wide-angle data, along, and off the ends of, the INDEPTH-2 CMP profiles in a continuous 400-km-long array from Pagri and Pomo Tso (Tso=lake) in the south, across the Tsangpo suture zone, to the north edge of Nam Tso. Several short term "extra-deployments" were carried out in conjunction with extra shots, to augment near-vertical data coverage in gaps between the CMP profiles, and to provide 3-D control for parts of the CMP profile.

Sensors and recording parameters

The permanent stations were equipped with three-component sensors of several types:
1. Mark Products L-28 (4.5 Hz).
2. Mark Products L-4 (1 Hz).
3. Guralp broad-band sensors (100s-100Hz).

The broad-band stations were equipped with GFZ-Potsdam, 72A-07, 3-channels, 24 bit, REFTEK recorders and recorded 24 hours-per-day continuous 50 samples-per-second (sps) data to a 500 Gb disk in compressed format. The other permanent stations were initially equipped with IRIS-PASSCAL, 72A-06, 3-channels, 16 bit, REFTEK recorders and recorded 100 sps data to a 230 Mb disk during 6 hours (shooting window) every day in sleep/wake mode. Some L-4 stations were later equipped with 72A-07 REFTEKs and turned to record 50 sps data 24 hours per day in continuous mode. Extra deployments were equipped with whatever short period sensor or REFTEK recorder that were available and recorded 100 sps in sleep or continuous modes (according to timing requirements).

Timing

All permanent stations were equipped with 111-A GPS clocks and preserved generally accurate absolute timing. One exception is station 11 that did not have an active GPS during the shooting of FFID's 60002-80046 and therefore has timing errors of up to hundreds of milliseconds. Extra deployments were either equipped with a GPS clock or left in continuous mode and given time pulses from a GPS clock at turn-on and end of the recording period (then timing was corrected for a linear drift). An error of 20 ms existed in all 72A-06 REFTEKs. This error was corrected for by inserting a static correction to the data headers.

Absolute timing of the CMP shots was obtained using a combination of three methods:
1. A top-of-the-minute pulse from a 111-A GPS clock was recorded on auxiliary channel number 3 of the CMP Wave-3 recording system while the shot was recorded.
2. An IRIG code from a USGS Masterclock-2 was recorded on auxiliary channel number 6. The Masterclock was corrected at beginning and end of every day using the GPS clock and the clock drift was taken into account.
3. The electrical shot-box pulse, and the up-hole phone, were recorded by a REFTEK that was timed by the same GPS clock.

The extra shots, that were not recorded by the CMP recorder were timed using method 3 above or triggered by the Masterclock on the top of the minute.

All together shot times are correct to the sample rate (±10 ms). Exceptions are FFID's 50016-50024 that were timed only by a wrist-watch and have timing errors in the order of several seconds.

Power supply

The broad-band stations were equipped with two 50 A-hr sealed lead-acid batteries and two solar panels with version 2.2 power-boards. The other stations were equipped with local car batteries and usually with a single solar panel and version 2.2 power-boards. Several of these stations suffered from low power, and electrical glitches, originating from the solar-panels power-boards (two opposite polarity spikes separated by about ten seconds) or the engine of the disk (intense, several seconds long noise), contaminate the data. An attempt to ground the stations worsened these glitches.

Problems in acquisition

Various problems during acquisition caused loss or damage of data. Main factors were:
1. Vandalism: several stations were stolen by locals and others were mechanically damaged. Damages included cutting of sensor cables which caused for acquisition of meaningless data. Fortunately most damages were caused to the solar panels and many times did not damage data acquisition.
2. Glitches, in particularly the solar-panel power-board electric noise discussed above.
3. Dead lithium batteries and loose internal boards (due to missing cross-bars) caused resets of the REFTEK's program.
4. Water intruding into the REFTEK unit, by flooding or condensation, caused the acquisition to stop in several cases.

Data reduction

Most data were dumped in the field directly from the REFTEK disks on to 4 mm DAT tapes. These data were then dumped to the computer using "ref2segy" to produce PASSCAL SEG-Y files of the entire data-set which were backed-up to tar-tapes (all field data-tapes are archived with us). After obtaining the absolute shot times (and correcting them where needed/possible) they were used as input to the program "segygather" that truncated the field data to 2 minute shot records (records beginning at the shot time) and produced PASSCAL SEG-Y files for each shot. In the final stage header values were calculated and a modified version of "segygather" was used to produce standard SEG-Y reel files for each station. Note that "segygather" cuts the trace at the nearest sample to the shot time and does not interpolate the data to begin the trace at the exact shot time. We preserved absolute times of both the shot and the actual beginning of the trace in the headers. Receiver locations were obtained from a combination of hand GPS, 1:100,000 Chinese maps, and the GPS clocks of the stations. Shot locations were provided by the Chinese seismic crew survey team (surveyed by EDM). Offset and azimuth were computed using USGS "map" program with the spherical earth taken into account. Additional field parameters, like the instrument serial-number, sensor type, data-format etc., were also preserved in the trace headers. The SEG-Y reel files were input into ProMax (from Advance Geophysical, a Landmark company) and the tapes sent to PASSCAL were output from ProMax to tape, a file for each permanent station and a file for each set of extra deployments.

CONTENT OF TAPES:

Each tape contains a number of SEG-Y REEL files. The files are usually data of a single station and are named STxxx for short-period station number xxx or BBxxx for broad-band station xxx. Exceptions are the files containing data from extra short-term deployments (files Extra-xxxx) carried out in Nimu valley (stations 100's and 500's) and in the north part of the INDEPTH CMP profile (stations 300's and 400's).
Each SEG-Y file is sorted by STATION (1-600) : FFID (1-12000) : CHAN (1-3) (see headers description).

TAPE 1: 100 SPS DATA

tape file #	file name	# of traces
1	ST001	2478
2	ST002	2298
3	ST004	2802
4	ST006	2697
5	ST007	2892
6	ST011	1398
7	ST012	2643
8	ST013	1758
9	ST015	1689
10	ST017	2001
11	ST019	2451
12	ST021	2805
13	ST022	2868
14	ST023	1410
15	ST024	2364
16	ST025	1668
17	ST026	2892
18	ST027	651
19	ST029	1992
20	ST030	897
21	ST032	2172
22	ST033	2169
23	Extra-Nimu	292
24	Extra-North	1140

TAPE 2: 50 SPS DATA

tape file #	file name	# of traces
1	ST001.50sps	66
2	BB005	2571
3	BB008	2088
4	BB010	2658
5	BB014	2766
6	BB018	1560
7	BB020	2724
8	BB023	2373
9	ST025.50sps	888
10	ST027.50sps	933
11	ST030.50sps	237
12	BB034	2031
13	BB036	2451

SEG-Y TRACE-HEADERS DESCRIPTION:

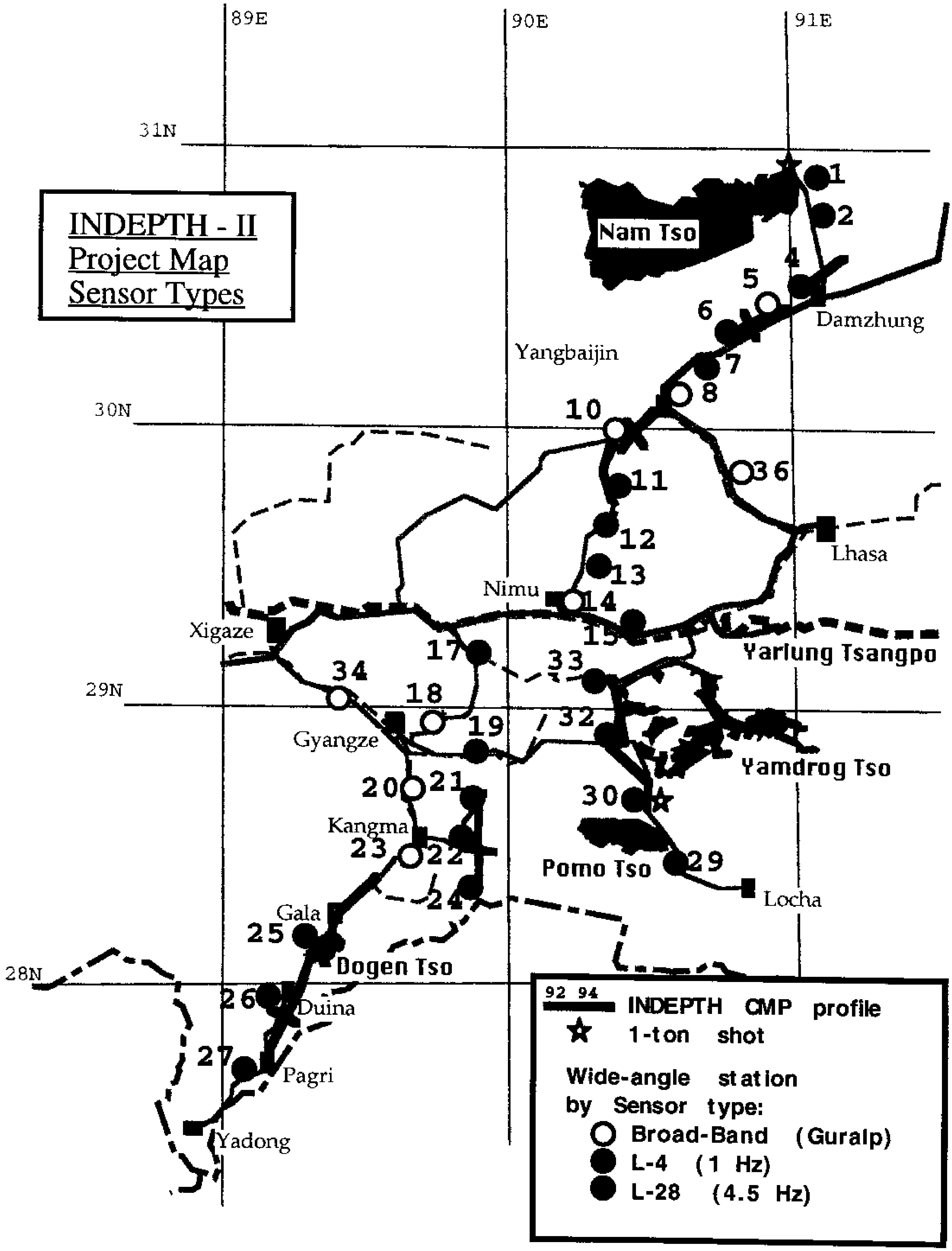
header word	size	byte-start	description
Standard SEG-Y headers:			
ffid	long	9	field file ID number by Cornell's scheme
source	long	17	same
channel	long	13	component: 1=vertical, 2=north, 3=east
offset	long	37	absolute value of source receiver distance in m
source_depth	long	49	dynamite load in kg (+1 if it is extra shot)
sou_long	long	73	source longitude in sec of arc
sou_lat	long	77	source latitude in sec of arc
sou_elev	long	41	source elevation in m
rec_long	long	81	receiver longitude in sec of arc
rec_lat	long	85	receiver latitude in sec of arc
rec_elev	long	45	receiver elevation in m
rec_stat	short	101	receiver static correction in msec
tot_stat	short	103	total static correction in msec
You need to overwrite SEG-Y headers for:			
rec_sloc	long	61	receiver surface location projected to the CMP line
sou_sloc	long	65	source surface location
sensor	short	133	sensor type: 1=L-28, 2=L-4, 3=BB
azimuth	short	171	source-receiver azimuth
station	short	173	wide-angle station number
old	short	175	ffid assigned by us in the field
cdp_y	real	181	midpoint latitude in sec of arc
cdp_x	real	185	midpoint longitude in sec of arc
dataform	short	205	data recording format (0=16 bit; 1=32 bit)
inst_no	short	225	DAS number
max	short	233	maximum value in counts
min	short	233	minimum value in counts
absolute time of begining of trace (from first live sample):			
year	short	157	
day	short	159	
hour	short	161	
min	short	163	
sec	short	165	
msec	short	207	
absolute shot-time:			
trigyear	short	209	
trigday	short	211	
trighour	short	213	
trigmin	short	215	
trigsec	short	217	
trigmsec	short	219	

In ProMax SEGY-INPUT you need to overwrite SEG-Y headers for:
cdp,,4i,,21/cdp_y,,4r,ieee,181/cdp_x,,4r,ieee,185/sou_sloc,,4i,,65/rec_sloc,,4i,,61/
azimuth,,4i,,171/sensor,,2i,,133/station,,2i,,173/old,,2i,,175/year,,2i,,157/day,,2i,,159/
hour,,2i,,161/min,,2i,,163/sec,,2i,,165/msec,,2i,,207/trigyear,,2i,,209/trigday,,2i,,211/
trighour,,2i,,213/trigmin,,2i,,215/trigsec,,2i,,217/trigmsec,,2i,,219/dataform,,2i,,205/
inst_no,,2i,,225/max,,4i,,233/min,,4i,,237/

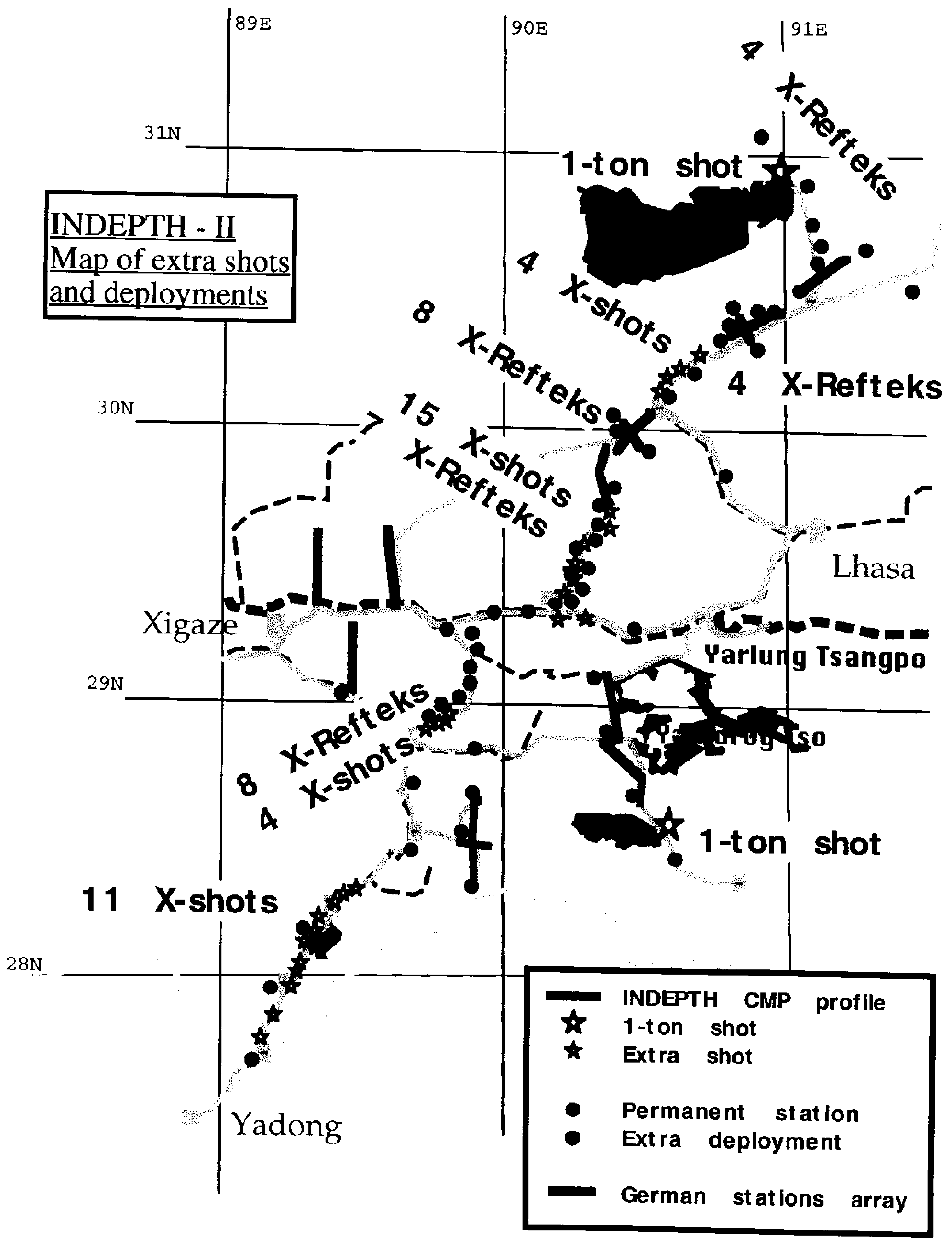
We follow Cornell's convention about ffid and surface location number:
number of ffid(or surface_location) in CMP line segment + line_number*10,000
for ffid: add 1000 if it is an extra shot
for sloc: extrapolated by geometry (distance north/25 meters + last sloc on CMP line)

STATION LOCATIONS AS MEASURED IN THE FIELD

Station	GPS location		elevation	location method	sensor
1	30 50.722	91 08.219	15600 ft	hand GPS	L4
2	30 44.997	91 06.215	15700 ft	hand GPS	L4
4	30 31.125	91 01.420	15300 ft	hand GPS	L28
5	30 22.797	90 54.615	13900 ft	hand GPS	BB
6	30 17.829	90 46.532	14500 ft	hand GPS	L28
7	30 13.288	90 38.990	15200 ft	hand GPS	L4
8	30 07.883	90 32.912	14300 ft	hand GPS	BB
10	29 59.935	90 24.846	14300 ft	hand GPS	BB
11	29 49.252	90 21.508	14900 ft	hand GPS	L28
12	29 39.907	90 21.436	15300 ft	hand GPS	L4
13	29 30.872	90 16.417	13400 ft	hand GPS	L28
14	29 22.148	90 11.064	12200 ft	hand GPS	BB
15	29 16.140	90 27.388	12700 ft	hand GPS	L28
17	29 12.245	89 54.171	13100 ft	hand GPS	L4
18	28 55.916	89 44.523	14500 ft	hand GPS	BB
19	28 50.669	89 51.847	14100 ft	hand GPS	L4
20	28 43.67015	89 39.8357	4197.8 m	GPS in 1992	BB
21	28 41.60	89 52.994	14200 ft	hand GPS	L28
22	28 32.060	89 49.919	15100 ft	hand GPS	L28
23	28 29.212	89 39.515	14300 ft	hand GPS	BB
24	28 20.040	89 49.409	16300 ft	hand GPS	L4
25	28 10.558	89 18.143	15200 ft	hand GPS	L4
26	27 57.590	89 09.798	15100 ft	hand GPS	L4
27	27 40.331	89 04.524	15300 ft	hand GPS	L4
29	28 27.469	90 31.883	17100 ft	hand GPS	L4
30	28 42.770	90 28.121	16600 ft	hand GPS	L28
32	28 55.477	90 21.807	15100 ft	hand GPS	L4
33	29 06.993	90 22.565	15100 ft	hand GPS	L28
34	29 06.567	89 15.378	12800 ft	hand GPS	BB
36	29 49.033	90 45.420	12800 ft	hand GPS	BB
103	28 58.95798	89 45.8513	4264 m	1992 GPS DAS 7241	L4
104	29 00.84	89 51.84	4400 m	map DAS 7260	L4
105	29 04.84	89 53.75	4160 m	map DAS 7203	L28
106	29 08.59	89 53.68	4080 m	map	L28
108	29 15.16	89 52.75	5060 m	map	L28
109	29 17.00	89 47.44	3880 m	map	L28
110	29 19.05	89 52.90	3800 m	map	L28
111	29 21.11	90 05.84	3760 m	map	L28
301	30 55.068	91 00.494	15800 ft	hand GPS	L28
302	30 52.700	91 03.173	15000 ft	hand GPS	L28
303	30 40.998	91 05.931	16500 ft	hand GPS	L28
304	30 33.443	91 07.221	14600 ft	hand GPS	L28
401	30 35.465	91 22.086	16400 ft	hand GPS	L28
402	30 41.346	91 05.579	17200 ft	hand GPS	L28
403	30 57.269	91 02.876	16400 ft	hand GPS	L28
404	30 33.556	91 27.742	14700 ft	hand GPS	L28
405	30 25.465	91 22.086	15400 ft	hand GPS	L28
501	29 44.851	90 22.190	14600 ft	hand GPS	L28
502	29 37.095	90 20.809	15700 ft	hand GPS	L28
503	29 34.766	90 16.409	13200 ft	hand GPS	L28
504	29 27.272	90 15.399	12900 ft	hand GPS	L28
505	29 24.584	90 12.373	12100 ft	hand GPS	L28
506	29 21.311	90 05.393	11800 ft	hand GPS	L28
507	29 19.315	89 56.168	11900 ft	hand GPS	L28



INDEPTH - II
Project Map
Sensor Types
89E
90E
91E
31N
30N
29N
28N
Nam Tso
Damzhung
Yangbaijin
Lhasa
Nimu
Xigaze
Yarlung Tsangpo
Gyangze
Yamdrog Tso
Kangma
Pomo Tso
Locha
Gala
Dogen Tso
Duina
Pagri
Yadong
1
2
4
5
6
7
8
10
11
12
13
14
15
17
18
19
20
21
22
23
24
25
26
27
29
30
32
33
34
36
92 94
INDEPTH CMP profile
1-ton shot
Wide-angle station
by Sensor type:
Broad-Band (Guralp)
L-4 (1 Hz)
L-28 (4.5 Hz)



INDEPTH - II
Map of extra shots
and deployments
89E
90E
91E
31N
30N
29N
28N
4 X-Refteks
1-ton shot
4 X-shots
8 X-Refteks
4 X-Refteks
15 X-shots
X-Refteks
Lhasa
Xigaze
Yarlung Tsangpo
X-Refteks
X-shots
8
4
1-ton shot
11 X-shots
Yadong
INDEPTH CMP profile
1-ton shot
Extra shot
Permanent station
Extra deployment
German stations array