ALP 2002 SEISMIC EXPERIMENT

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1. INTRODUCTION

The Alps are one of the most famous and interesting mountain belts in the world and have intrigued geoscientists for centuries. They can be thought of as the southern boundary of the relatively stable lithosphere of Western and Central Europe. The western and central Alps have been the target of many lithospheric scale geophysical experiments, but such data are sparse in the eastern Alps and not sufficient to answer many key geologic questions (*Scarascia and Cassinis, 1997*; *Yan and Mechie, 1989*). Thus, ALP 2002 was organized as an international seismic experiment whose scientific objective is to further scientific understanding of the structure and evolution of the lithosphere in the Eastern Alps and surrounding areas. As discussed in *Guterch et al. (2003)*, the CELEBRATION 2000 seismic experiment was a massive effort and included some observations in the northeastern Alps and western Pannonian basin. However, the focus of this effort was further north and east. Thus, a major consideration in the design of the ALP 2002 project was to build on the CELEBRATION 2000 effort and provide comprehensive seismic coverage in the eastern Alps region.

In the western portion of our region of interest (TRANSALP profile region; *Transalp Working group, 2002*), the Alps are a classic collisional regime. However, in the far eastern Alps and adjacent areas to the east and south (Carpathians, Pannonian basin, Dinarides), we are dealing with a plate tectonic regime that is very complex. For example,

the Pannonian basin represents an unconstrained plate margin that is extending (*Posgay et al., 1995*). Although there is much debate about the details of the processes at work, the lithosphere east of the Alps was extruded laterally eastward in the Oligocene and Miocene (*Ratschbacher et al., 1991*) as indicated by many types of data. Even present day seismicity follows this pattern (*Aric and Gutdeutsch, 1987*).

The ALP 2002 experiment included passive seismic monitoring during portions of June and July 2002, and an active source seismic refraction experiment was conducted from 1 – 6 July 2002. Furthermore, local high-density deployments were carried out in Austria and Hungary to investigate local geologic problems. All data will be integrated with the goal of better understanding the geodynamic processes currently at work and the complex tectonic history of this region.

2. DESCRIPTION OF THE PROJECT

2.1 Controlled Source Experiment

During ALP 2002, ~1000 portable seismograph recorders were deployed (Table 1) to record earthquakes and 32 specially designed explosions (Table 2). In addition, there were 8 smaller explosions detonated in Hungary as part of a local 3-D experiment.

Although there were considerable variations due to local conditions and national procedures, the standard shooting configuration in Austria was to divide 300 kg of explosives between 5 – 8 boreholes 30 – 50 m in depth. In Hungary, Slovenia and Croatia, a similar approach was used. In the Czech Republic, quarries were used as sources. Some shots were fired by a GPS-controlled blasting device. For the others, the instant was provided by placing a Texan seismic recorder and geophone at a horizontal distance of 20 m to the nearest borehole.

The main type of instrument employed were the 'Texan' single channel recorders that are described in detail in *Guterch et al. (2003)*. We employed the same methodology of deploying instruments along a series of interlocking profiles (Fig. 1) as was used during CELEBRATION 2000. We are using these data to construct 2-D and 3-D models of the lithosphere containing structural and compositional information derived from P- and S-wave travel times and amplitudes. ALP 2002 also included the collection of more data in the Bohemian Massif, which is one of the primary structural blocks in Western Europe and lies primarily in the Czech Republic. This area was the focus of the SUDETES 2003 experiment (*Grad et al., 2003*).

The 'Texan' instruments available for ALP 2002 were as follows: Austria – 30, Denmark – 149, Finland – 10, Poland – 30 and USA – 728, which is a total of 947. They were programmed as follows:

- 243 time windows
- recording time in each window: 4 min 20sec
- sample rate: 100 Hz (10 ms)
- start of first window: 02 07 2002 17:59:00
- start of last window: 05 07 2002 03:59:00

In addition to the 'Texan' instruments, about 200 Canadian PRS recorders were used for a local deployment in Hungary and a SUMMIT telemetered recording system was used to record a local reflection line in Austria.

Table 1. Information on seismic shots.

Shot	Local Name	Longitude [deg E]	Latitude [deg N]	UTC	Charge [kg]
101	Bílina	13.7162	50.5732	2002:185:03:05:00.04	400
102	Tušimice	13.3292	50.4267	2002:185:03:15:01.22	10000
103	Číhaná	12.9854	50.1332	2002:184:18:20:05.54	800
104	Třebnuška	13.7290	49.8883	2002:184:04:00:01.61	10000
105	Zaječov	13.8500	49.7648	2002:185:18:30:01.42	2000
106	Kladruby u Stříbra	12.9686	49.7029	2002:184:19:00:13.34	500
108	Mítov	13.6673	49.5937	2002:184:18:30:02.67	2000
109	Hamr u Sušice	13.5409	49.2516	2002:184:18:00:00.29	2000
110	Schärding	13.4528	48.4100	2002:185:02:00:01.59	300
111	Attersee	13.4592	47.8211	2002:185:02:30:04.87	300
112	Schladming	13.5672	47.3261	2002:184:01:59:58.52	300
113	Gmünd	13.3894	46.9739	2002:186:02:10:00.13	300
114	Arnoldstein	13.5464	46.5539	2002:186:02:20:00.66	300
115	Gradin	13.8280	45.4519	2002:185:23:05:00.00	300
116	Istria	14.1324	44.9711	2002:186:04:40:00.00	300
201	Axamer Lizum	11.6447	47.1558	2002:184:02:30:03.54	300
202	Defereggental	12.2456	46.9158	2002:184:02:20:00.53	300
203	Oberdrauburg	12.9778	46.7300	2002:184:02:10:01.97	300
205	Bad Eisenkappel	14.5853	46.4106	2002:185:02:20:00.64	300
206	Vojnik	15.3228	46.2771	2002:182:23:05:00.00	300
207	Ivanic Grad	16.4649	45.7668	2002:185:02:40:00.00	300
208	Slavonski Brod	17.8444	45.0607	2002:184:02:40:00.01	300
503	Wolfsberg	14.9625	46.8331	2002:185:02:10:00.42	300
504	Mürzzuschlag	15.6069	47.4931	2002:186:02:00:01.30	300
603	Hungary	16.9048	47.5503	2002:183:22:00:00.00	700
702	Crikvenica	14.6982	45.1994	2002:185:02:50:00.00	300
801	Mitterdorf	15.4886	47.5478	2002:186:02:30:04.27	100
803	Hungary	16.6217	46.9319	2002:184:22:00:00.00	200
804	Hungary	16.4497	46.6503	2002:184:22:10:00.00	200
805	Hungary	17.1486	46.9178	2002:183:22:20:00.00	200
806	Hungary	17.0261	46.5772	2002:185:0:00:00.00	200
807	Hungary	17.5408	46.1325	2002:183:22:10:00.00	640
808	Hungary	16.6931	46.8367	2002:184:23:00:00:00	70
809	Hungary	16.7547	46.7200	2002:185:22:00:00:00	70
810	Hungary	16.6992	46.7861	2002:185:22:10:00:00	70
811	Hungary	16.7897	46.7394	2002:185:22:20:00:00	70
812	Hungary	16.7997	46.7228	2002:185:22:30:00:00	70
813	Hungary	16.8364	46.7053	2002:185:23:00:00:00	70
814	Hungary	16.7411	46.7800	2002:185:23:10:00:00	70

Table 2. Information on seismic lines.

lines	length [km]	Texan-stations	3C-stations
ALP01	645	212	0
ALP02	540	151	0
ALP03	200	33	0
ALP04	360	40	30
ALP05	390	64	0
ALP06	285	49	0
ALP07	245	72	0
ALP08	290	47	0
ALP09	335	55	0
ALP10	385	98	0
ALP11	190	32	0
ALP12	220	0	40
ALP13	190	26	0
ALP13b	38	47	0
TOTAL	**4313**	**926**	**70**

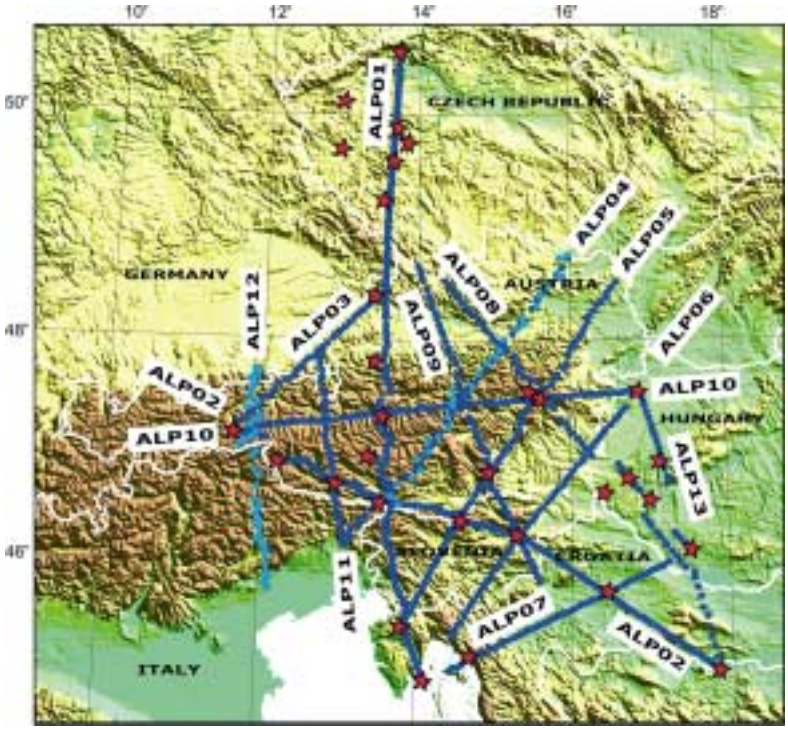

Fig. 1. Shot locations (red stars) and receiver lines (blue circles are Texans, cyan circles are 3C-stations for passive monitoring)

2.2. Passive Monitoring

The 3-component recorders were deployed from 07 June to 12 July 2002 along two profiles, ALP04 and ALP12. The ALP04 profile overlaps and extends CELEBRATION 2000 line CEL10. The passive monitoring along ALP04 was carried out by teams from Finland and Poland with support from Vienna University of Technology. The ALP12 profile follows the TRANSALP reflection line. The passive monitoring along ALP12 was carried out by the team of University Munich with support from Vienna University of Technology.

The instruments available to record these profiles were as follows:

1. ALPO4: 20 – MK-4P recording units (Poland) with Mark Products L-4-3D / 1 Hz seismometers
   10 – RefTek 72A recording units (Finland) with Mark Products L-4-3D / 1 Hz seismometers
2. ALP12: 40 – PDAS-100 recording units (Germany) with Mark Products L-4-3D and 1 Hz seismometers

2.3 Data Processing

Active source experiment

All raw data from the Texan-recordings are saved on several hard disks and tapes. The raw data of all shots and from the 'Texan' recorders were converted to SEGY, completed by adding geometry information and saved on CD-ROM. They were ready for distribution and interpretation (ZPLOT, ProMAX, etc.) within a few weeks of the experiment. Samples of recordings, demonstrating the quality of the data are shown on Figures 2a – d.

Passive experiment

Data preparation of the passive recordings along ALP04 and ALP12 was a separate task that was also completed quickly. The merged data set for all recordings of the shots was produced by end of August 2002. The first presentations of these data were made at the American Geophysical Union meeting in December of 2002 (ALP 2002 Working Group, Reporter: *Brückl E., 2002*) and at the TransAlp Conference (ALP 2002 Working Group, Reporters: *Brückl E. and Bleibinhaus F., 2003*) and European Geophysical Society meetings early in 2003 (Alp 2002 Working Group, Celebration 2000 Working Group, Reporter: *Brückl E., 2003*).

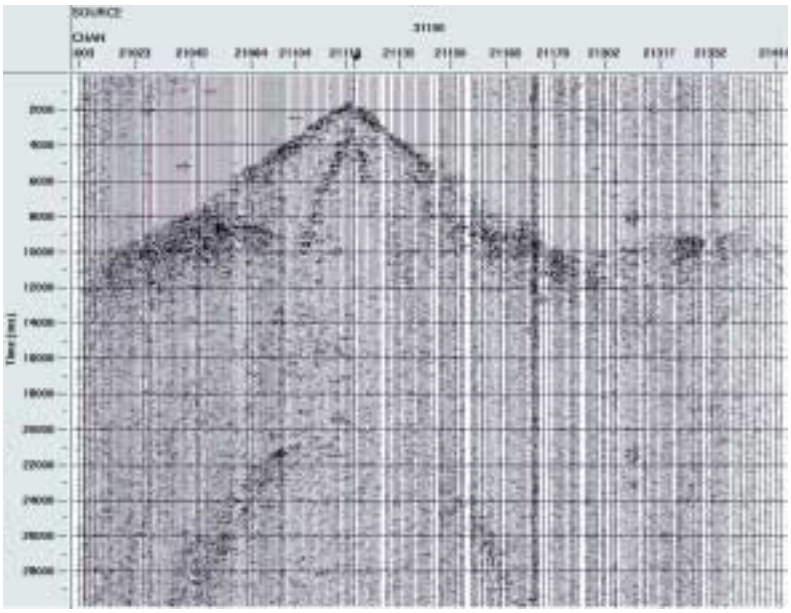

Fig. 2a

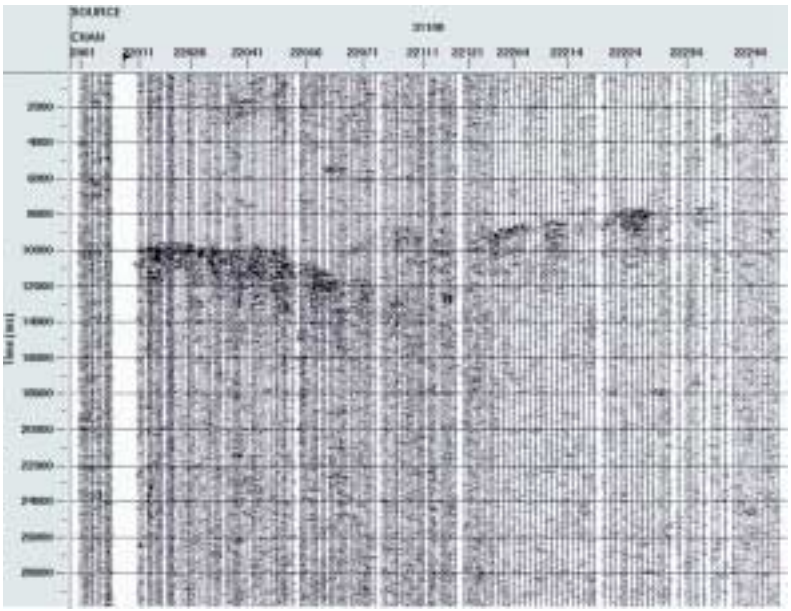

Fig. 2b

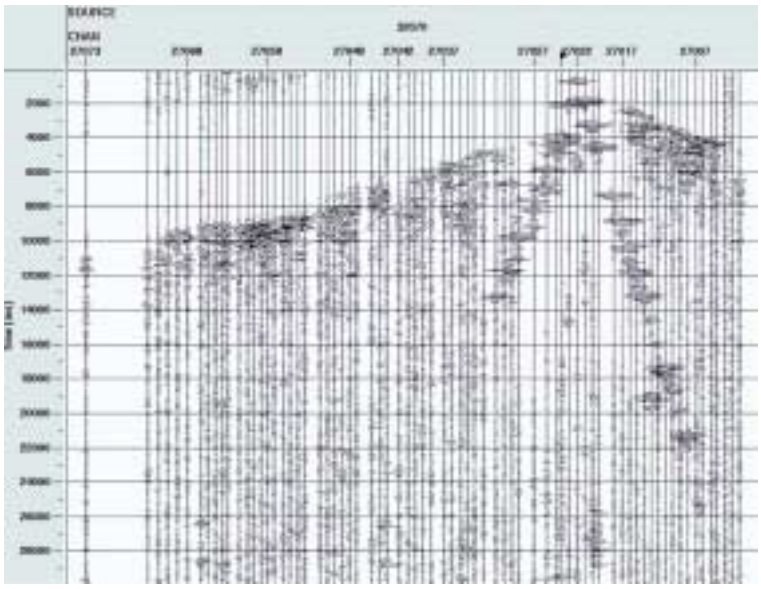

Fig. 2c

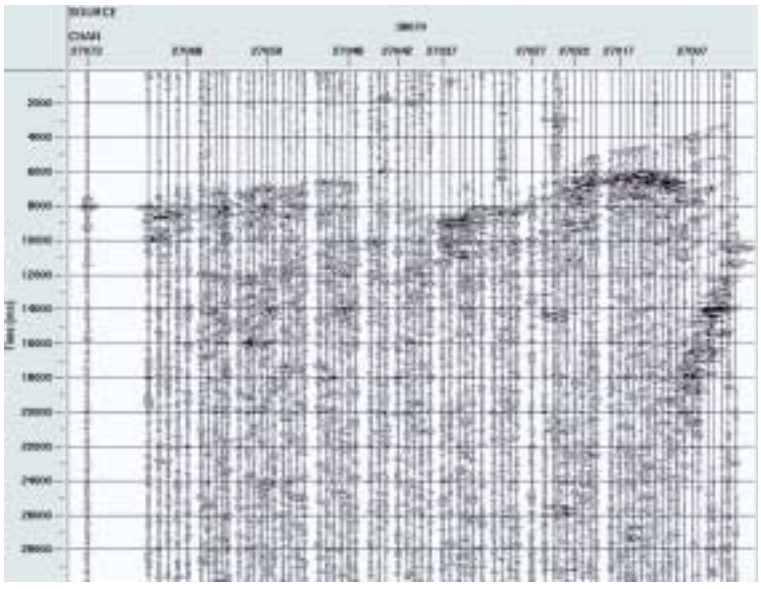

Fig. 2d

Fig. 2. Samples of record sections: a) Shot 101 on ALP01, b) Shot 101 on ALP 02, c) Shot 207 on ALP07, d) Shot 208 on ALP 07.

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