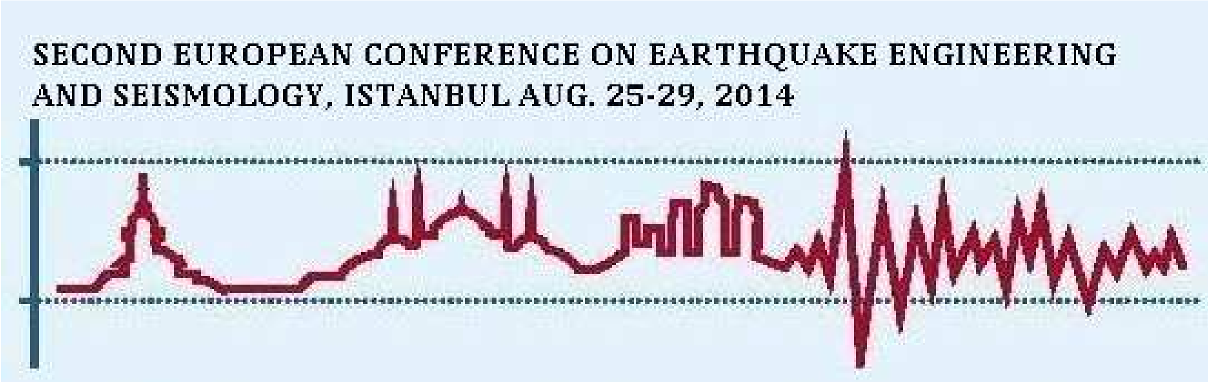

STATİON PERFORMANCE STUDY FOR CO-LOCATED SEİSMİC STATİONS AT THE CONRAD-OBSERVATORY

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Conrad Observatory is situated far away from roads and industrial areas on the Trafelberg in Lower Austria. At the end of the seismic tunnel, the main seismic instrument of the Observatory with a station code CONA is located. This station is one of the most important seismic stations in the Austrian Seismic Network (network code OE). The seismic observatory consists of a 145m long gallery and an underground laboratory building with several working areas. To enable an efficient use of seismic recordings and a possible optimization of our network in the future, the first investigation was conducted for data from three co-located stations with different conditions at the Conrad-Observatory: CONA (in the tunnel), CSNA (free field) and a station located in the borehole (COBA, only in this paper).

A comparison of noise spectra between the stations is followed in Figure 1 (only HHZ was employed). The top graph in this figure mixed spectra from all stations over all intervals. Due to the good instrument response in the low frequency range, station COBA (blue) gave a significantly low noise values for frequencies smaller than 0.5 Hz. Benefitting from the borehole isolation from local noise and certain noise amplification, the lowest noise level can be observed at COBA. Compared to station CSNA (green), CONA (red) demonstrated a relatively lower noise and confirmed an effective isolation of tunnel from the noise. The bottom three graphs in Figure 1 illustrated noise comparison for each time interval. Significantly low noise level can be found at COBA in the high frequency range. In the night hours, noise level at CONA is closer to the curves from CSNA but during the day hours, CONA noise level is only slightly higher than the COBA values.

In addition, dependence of station detection performance on the site effects was evaluated. Detection processing was re-run under the same condition for all three stations. Table 1 summarized number of valid detection found for each signal group. The second column also listed detection numbers given by the reviewed catalogue. Any enormous differences cannot be found between the stations. However, station COBA seems to have a better performance at detecting teleseismic signals and primary phases of rockbursts. Station CSNA is more sensitive to primary arrivals of local and regional mining but less capable to detect secondary phase of rockbursts and teleseismic signals. Generally all three stations delivered a very poor performance in detecting Sg/Sn phases. This might be the result of low SNRs estimated for Sg/Sn caused by signal tails of primary phases.

Accuracy of the onset time was compared to the time in the catalogue. Table 2 listed averaged onset time errors. CONA provided the best measurements for both primary and secondary arrivals. COBA gave a good onset times for primary phases, while the time accuracy for secondary arrivals reached 1.32 seconds (the worst among all stations). Onset times at CSNA for primary phases delivered the biggest errors.

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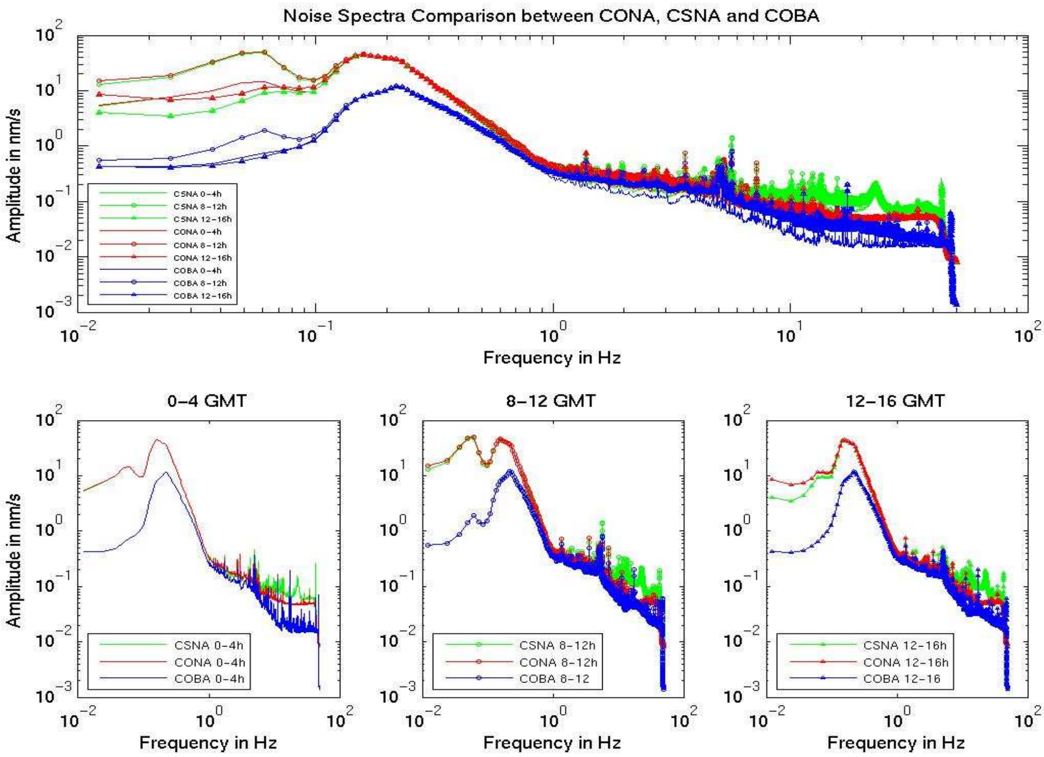

Figure 1: Noise spectra comparison between CONA, CSNA and COBA.

Table 1: Summary of valid detections found by COBA, CONA and CSNA

Valid Detections Associated	Event Types / Number of Detections in Catalogue	Phase	COBA	CONA	CSNA
	Local Earthquakes Pg/Pn: 7; Sg/Sn : 6	Pg/Pn	7	7	7
		Sg/Sn	2	2	2
	Regional Earthquakes Pn/Pg: 23; Sn/Sg; 11	Pn/Pg	19	20	19
		Sn/Sg	2	2	2
	Distant Earthquakes (85)	P	70	69	67
	Local/Regional Explosions Pg/Pn: 33; Sg/Sn: 37	Pg/Pn	6	7	8
		Sg/Sn	11	11	10
	Nuclear Explosions (1)	P	1	1	1
	Local/Regional Rockburst Pg/Pn: 21; Sg/Sn: 22	Pg/Pn	11	8	8
		Sg/Sn	2	3	0
Unassociated	Local/Regional Events	Pg/Pn	85	82	87
		Sg/Sn	15	15	13
Total Valid Detections			231	227	224

Table 2: Averaged onset time difference to catalogue

Phases	CONA	CSNA	COBA
Pg/Pn/P (103)	0.31	0.63	0.49
Sg/Sn (14)	0.55	1.06	1.32

Finally the maximal amplitudes of all valid signals were re-measured and compared between the stations. By using amplitudes at CONA as a reference, amplitude ratios of COBA (blue bars) and CSNA (green bars) to CONA were presented in Figure 2. The majority of ratios are concentrated around one, i.e. having comparable amplitudes over all three stations. However, there are about 30% of the maximum amplitudes at COBA that only have half-values of the CONA measurements (this corresponds to -0.3 of a magnitude unit), while about one fourth of amplitudes at CSNA have a ratio larger than 1.0 (larger magnitude). This indicated that station COBA has the smallest influence of the surface amplification, while station CSNA showed the largest impact from the surface amplification. In order to see if there is any influence of apparent attenuation to our amplitude measurements, Figure

1 displayed a relationship between the amplitude ratios and distances. No obvious distance dependence was observed in this figure.

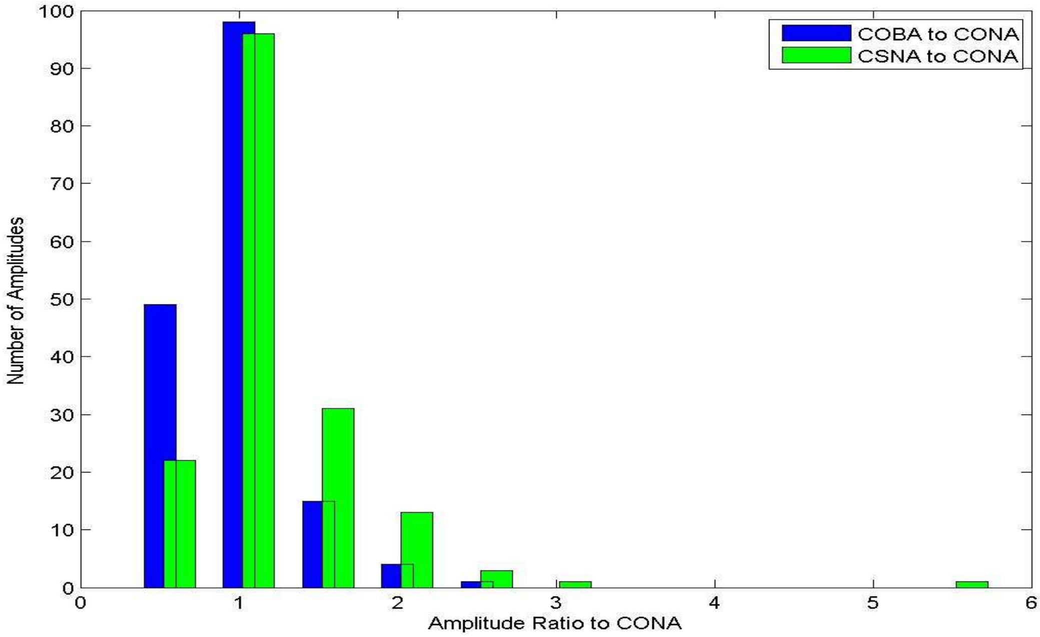

Figure 43: Comparison of amplitude ratios to CONA between CSNA and COBA.

An averaged magnitude difference to station magnitudes at CONA was estimated for CSNA and COBA. Station CSNA gave a positive magnitude difference of 0.03 unit to CONA values, while COBA presented a negative magnitude residuals to CONA values (difference only -0.06 unit). Both differences are negligible. However, absolute magnitude residuals of both stations to CONA magnitudes gave a same value of 0.12.

As the second step, three walls were built inside of the seismic tunnel, in order to prevent possible disturbances by air pressure and temperature fluctuation. The first wall is located ca 63 meters from the tunnel entrance, while a set of double walls with a distance of 1.5 meters is placed about 53 meters from the first isolation wall. About 25 meters away from the station CONA, six temporary seismic stations were implemented for research purposes. Two of them were installed with the same equipments (same sensors and digitizers) as CONA, while the remaining four stations were set up with same sensors (STS-2) but digitizers with lower noise and higher resolution (Q330HR). The double walls separated the station CONA and the six temporary stations. It was found there was no significant imporvement at the noise reduction and detection performance made by the walls.

SUMMARY

Benefitting from a good protection of borehole from local noise and surface amplification, the borehole station COBA showed the lowest noise level overall. Due to the advantage of effective isolation of tunnel from some local noise and noise during the day, station CONA presented a lower noise level than CSNA in the free field. Borehole is more effective to isolate stations from noise than the tunnel.

Station COBA is more sensitive to detect teleseismic signals and primary phases of rockbursts. This conclusion agreed well with the spectrogram study. Station CSNA performed well to detect primary phases of local and regional explosions but less capable to make teleseimic detections.

Station CONA delivered the best onset time measurements based on the catalogue times at CONA. Station COBA showed the worst onset times for secondary phases, while CSNA presented the biggest errors for primary arrivals.

Majority of the maximum amplitudes are comparable between all stations. Around 30% of detections at COBA only have half-values of amplitudes estimated at CONA, while about 25% of amplitudes at CSNA are at least 1.5 times of the values measured at CONA.