

Detection capability of 3-component seismic stations and tripartite mini-arrays: CTBT monitoring of artificial nanoevents with $M < 0$

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Introduction

On-site inspection (OSI)
- one element of verification within the Comprehensive Nuclear-test-ban Treaty (CTBT)

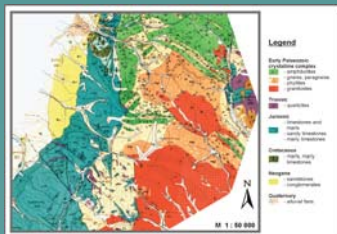
- Seismic monitoring of aftershocks – one allowed technique within an OSI
- Inspected area – up to 1000 km²
- an OSI follows not earlier than 3 weeks after occurrence of suspicious event
- Expected size of possible aftershocks is as low as $M_I = -2$

How many stations are necessary for homogeneous coverage of inspected area?

Experiment in Oct. 2004 in Slovakia – a contribution to answer the question

Detection capability of 3-component stations and tripartite mini-arrays were compared

Place of the experiment



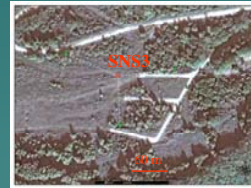
Organization of the experiment

Profile measurements

- two profiles of 3-component stations
- first profile 8 stations(1-8), second profile 7 stations (A-G)
- approx. 500m spacing between stations

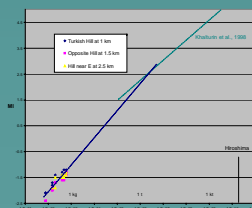
Tripartite mini-arrays (see Joswig, 2000)

- a 3-component seismometer in the center ,
- 3 vertical seismometers approx. 100m from the center
- at 1km, 1.5 km and 2.5 km from the explosions (SNS1-3)



Simulation of events (see Labák & Fojtíková, 2004)

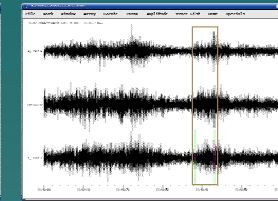
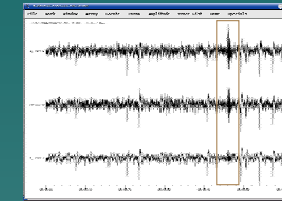
- 38 Explosions of TNT
- 6 series of 75g, 150g, 200g, 400g, 475g and 600g TNT
- 2 calibration shots 1000g and 2000 g
- 24 boreholes, 20 cm diameter, 3-5 m deep
- explosive at the bottom
- filled in by drilled material
- concrete block on the top of the borehole



Origin Time	Yield [g]	SNS1 1.0 km		SNS2 1.5 km		SNS3 2.5 km	
		M_I	comments	M_I	comments	M_I	comments
08:43:45	75	2.1	detected	1.8	detected	1.3	not weak
08:47:20	150	2.7	detected	2.2	detected	1.7	detected
08:50:55	200	3.1	detected	2.5	detected	1.9	detected
08:54:40	400	3.8	detected	3.3	detected	2.4	detected
08:58:25	475	3.9	detected	3.4	detected	2.5	detected
09:02:05	600	4.1	detected	3.6	detected	2.6	detected
09:35:55	75	2.1	detected	1.8	detected	1.3	detected
09:39:20	150	2.7	detected	2.2	detected	1.7	detected
09:43:30	200	2.9	detected	2.4	detected	1.8	detected
09:47:10	400	3.7	detected	3.2	detected	2.3	detected
09:51:50	475	3.8	detected	3.3	detected	2.4	detected
09:55:50	600	4.0	detected	3.5	detected	2.5	detected

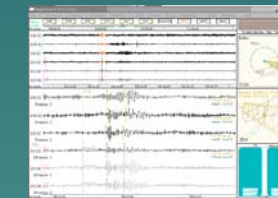
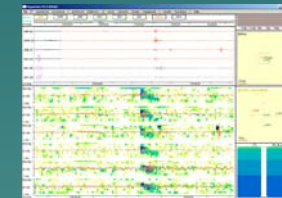
Magnitude M_I (Joswig, 2004) computed from tripartite mini-array records, yield is given in [g] of TNT

Results



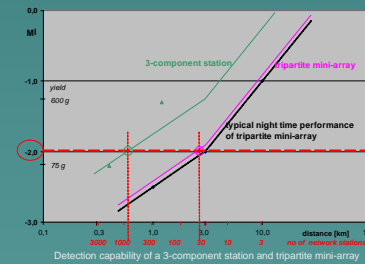
75g explosion - a day without wind - recorded by a 3-component station at distance of 500 m

75g explosion - a windy day - recorded by a 3-component station at distance of 500 m



Detection of 600g explosion by a SNS at 1.5 km distance

Location of 75g explosion by two SNS



3-component stations

Yield [g]	detection threshold [m]
75	340-500
150	340-500
200	1200
400	1900
475	2600
600	2600

Tripartite mini-arrays

Yield [g]	localization capability [m]
75	1500
150	1500
200	2500
400	2500
475	2500
600	2500

Conclusions

Detection capability of a 3-component station is 340-500 m for a $M_I = -2$ event.
Localization capability of a tripartite mini-array is 1500 m for the same event.

Therefore, more than 400 3-component stations or 35+ tripartite mini-arrays is needed for homogeneous coverage of a 1000 km² area.

References

- Joswig, M., 2004. Nanoseismic monitoring – part I: theory and first applications. *Subm. to Geophys. J. Int.*
- Joswig, M., 2000. Automated event location by seismic arrays and recent methods for enhancement. In: *Advances in seismic event location*, eds. C. H. Thurber & N. Rabinowitz, Kluwer, Dordrecht, 205-230.
- Labák, P., Fojtíková, L., 2004. DE04 OSI Field Exercise – preparation phase. In: *10th OSI CTBTO Workshop*, 18 - 22 October 2004. CTBTO, Vienna, 16 p.

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