The NPE2024 event analysis and characterization at the Kenyan National Data Centre (KE-NDC)

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INTRODUCTION AND MAIN RESULTS

This presentation demonstrates how results from abstracts presented during SnT conferences can be turned into publications where such results become products which can subsequently be utilized by NDCs. The presentation also demonstrates inter NDC cooperation during NPE exercises e.g. Kenya and Tanzanian NDCs, timely NDCs-IDC interactions, utilization of IMS data and IDC products for Treaty verifications, and the usage of IDC software tools provided to NDCS of CTBT member states.

SnT 2025 8 SEPTEMBER ONLINE DAY 9 TO 12 SEPTEMBER AT HOFBURG PALACE, VIENNA & ONLINE
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Introduction

During SnT2023, Mulwa and Dindi (2023) presented case examples of systematic seismic events discrimination methods at KE-NDC. The results were subsequently published in Pure and Applied geophysics journal (see Mulwa, 2024 in PAGEOPH, https://doi.org/10.1007/s00024-024-03458-4).

NPE2024 entailed a request by the State of "Andlantis" for Expert Technical Analysis (ETA) of potentially CTBT-relevant event in the State of "Bezores". Andlantis provided "CTBT Member States" with SHI data from her National Technical Means (NTM), comprising four seismic stations (CEN, DOG, OA1, OA2) and two infrasound stations (IA1 and IA2).

At KE-NDC, the seismic waveform data was bandpass filtered using low to high corner frequencies of 0.01 to 0.05 Hz respectively, taking into account that the sampling rate for the seismic stations was 0.5 Hz. Preliminary P-, S- and LR seismic phases were picked on all seismograms. The seismic event was located at latitude 41.0872°N and longitude 27.9954°S (Fig.1). The origin time of the seismic event was 20240114 06:19:36.36, the origin time being local Andlantis time zone (i.e. 08:19:36.36 UTC).

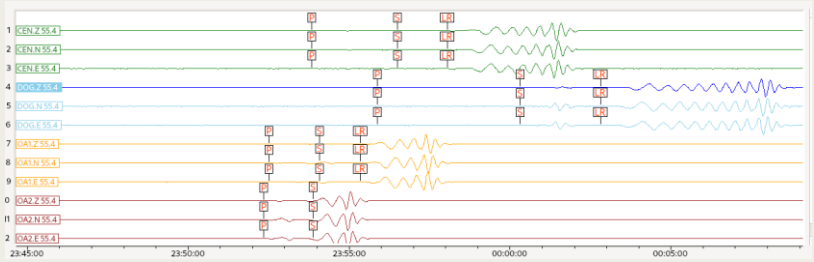

Figure 1: Waveform data by Andlantis processed and analyzed at KE-NDC

	lat	lon	depth	time	orid	evid	jdate	nass	ndef	ndp	grn	srn	etype	depdp	dtype	mb	mbid	ms	msid	ml	mlic
1	41.0872	-27.9954	0.0000	2024-01-14 06:19:36.36	151...	-1	2024014	11	8	0	404	32	-	-999.0000	g	-999.00	-1	-999.00	-1	-999.00	

	Use	Phase	T	A	S	sta	P..-2	timeres..-2	T..-2	azimuth	azres..-2	A..-2	slow	slores..-2	S..-2	delta..-2	time
1	☑	P	d	n	n	CEN	P	0.01	d	-1.00	160.80	n	-1.00	-999.00	n	14.50	2024-01-14 06
2	☑	P	d	n	n	OA1	P	2.69	d	-1.00	-139.16	n	-1.00	-999.00	n	8.43	2024-01-14 06
3	☑	P	d	n	n	OA2	P	-1.26	d	-1.00	-38.53	n	-1.00	-999.00	n	7.95	2024-01-14 06
4	☑	P	d	n	n	DOG	P	0.70	d	-1.00	109.29	n	-1.00	-999.00	n	25.23	2024-01-14 06
5	☑	S	d	n	n	CEN	S	-3.68	d	-1.00	160.80	n	-1.00	-999.00	n	14.50	2024-01-14 06
6	☑	S	d	n	n	DOG	S	-0.29	d	-1.00	109.29	n	-1.00	-999.00	n	25.23	2024-01-14 06
7	☑	S	d	n	n	OA2	S	-1.12	d	-1.00	-38.53	n	-1.00	-999.00	n	7.95	2024-01-14 06
8	☑	S	d	n	n	OA1	S	-0.15	d	-1.00	-139.16	n	-1.00	-999.00	n	8.43	2024-01-14 06
9	☑	LR	n	n	n	CEN	LR	32.04	n	-1.00	-999.00	n	-1.00	-999.00	n	14.66	2024-01-14 06
10	☑	LR	n	n	n	OA1	LR	45.63	n	-1.00	-999.00	n	-1.00	-999.00	n	8.63	2024-01-14 06
11	☑	LR	n	n	n	DOG	LR	-20.17	n	-1.00	-999.00	n	-1.00	-999.00	n	25.31	2024-01-14 06

Figure 2: Epicentral location of triggering event obtained after ETA of seismic data provided by Andlantis

Figure 3: Epicentral location of triggering event in Bezores after ETA

"Screening" of IDC products

The event date and OT (2024/01/14 08:19:36.36 UTC (Andlantis time: UTC-2 hours) and the arrival times of seismic phases at the four stations were used to give clue of possible triggering event from the IDC products. "Screening" results of IDC products confirmed one probable triggering event with the following parameters: REB EventID: 25417955; OrigID: 25443085; Location: Azores Islands (Bezores for NPE2024 exercise purpose); Date: 2024/01/14, OT: 08:19:54.350.

Analysis of waveform data for the triggering event at KE-NDC

Seismic and HA waveform data for the triggering event were requested from IDC. Additional seismic waveform data was requested from IRIS DMC. Sample results from processing and analysis of seismic and HA waveforms are shown in Figures 4, 5, 6, 7, 10, 11 and 12 :-

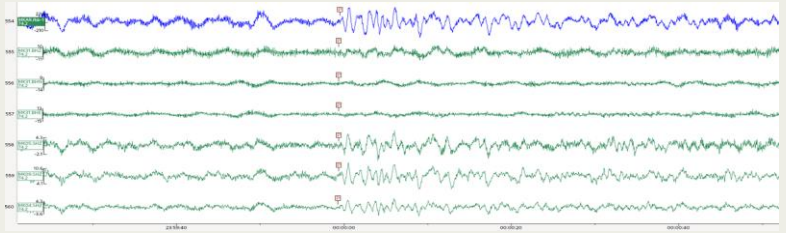

Figure 4: FK analysis for seismic array station MKAR

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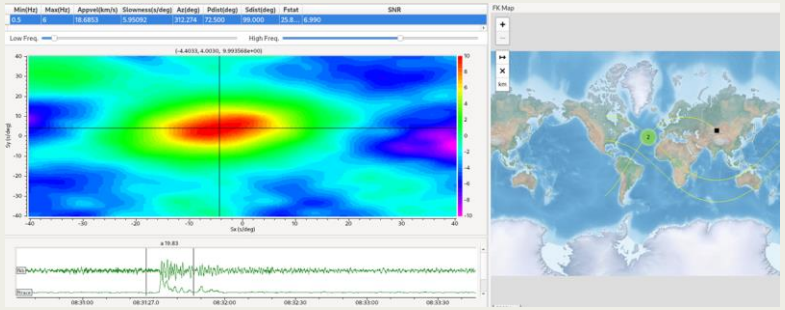

Figure 5: Results of FK analysis of waveform data for seismic array station MKAR

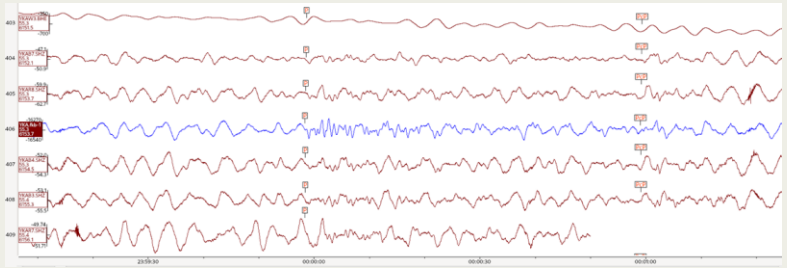

Figure 6: FK analysis for seismic array station YKA

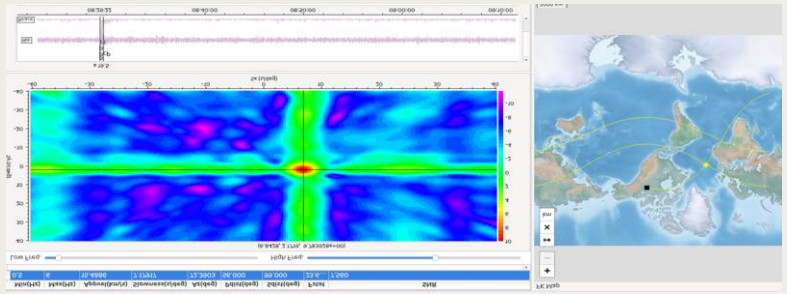

Figure 7: Results of FK analysis of waveform data for seismic array station YKA

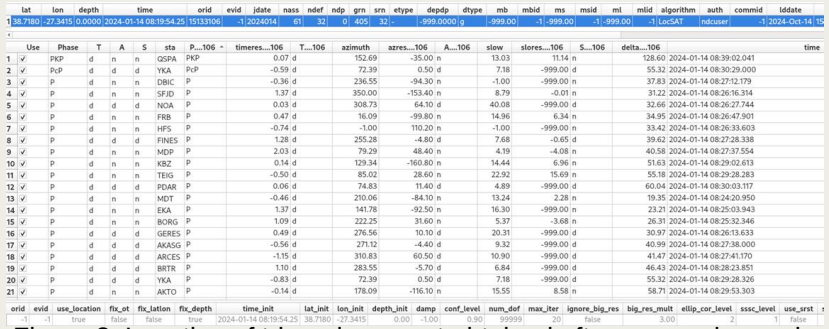

Figure 8: Location of triggering event obtained after processing and analysis of waveform data from REB EventID 25417955 (NB: Not all stations used presented here)

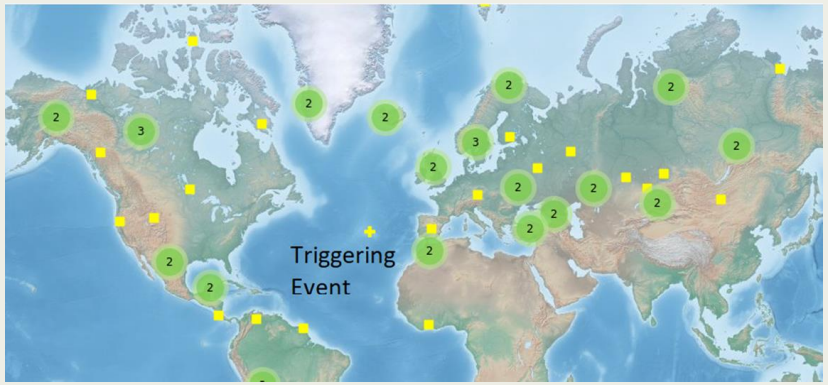

Figure 9: Epicentral location of triggering event in Bezores after processing and analysis of waveform data from REB EventID 25417955

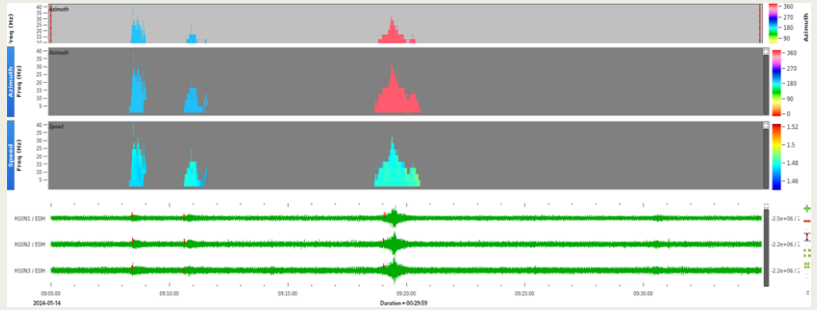

Figure 10: Waveform, Azimuth and speed Pixels for hydroacoustic station H10N

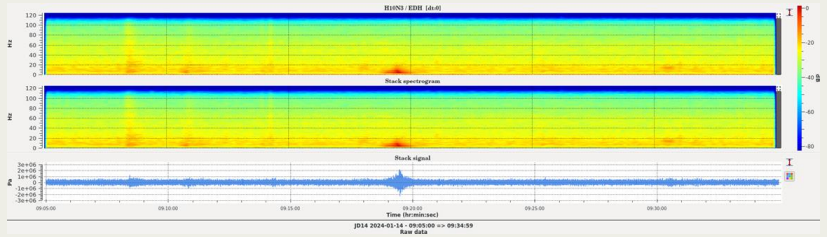

Figure 11: Spectrogram for hydroacoustic data at H10N3

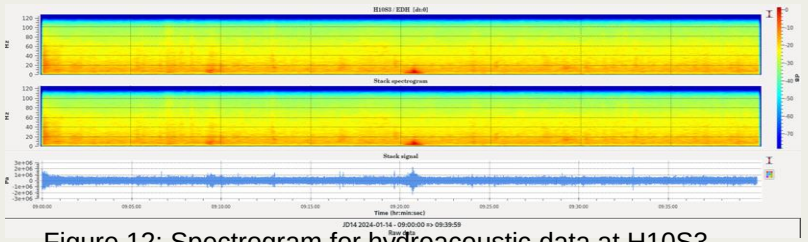

Figure 12: Spectrogram for hydroacoustic data at H10S3

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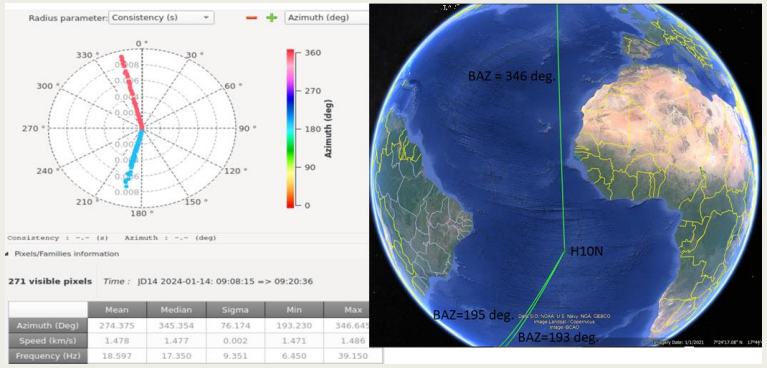

Figure 13: Polar plot and azimuth projection at Hydroacoustic station H10N

Characterization of the triggering event in Bezores

In order to determine if Bezores violated the CTBT, the seismic event: (date, origin time and depth of 2024/01/14, 08:19:54.25, d=0 km), was subjected to m_b:M_s, frequency content of the hydroacoustic signal and focal mechanism discriminants.

The m_b 4.2 (IDC), 5.1 (ISC) and M_s 3.8 (IDC and ISC) were plotted on m_b:M_s regression plot by Bowers and Selby (2009). On the basis of the m_b:M_s regression relationship of the triggering event in Bezores, the discrimination of the event as either natural or anthropogenic is indeterminate.

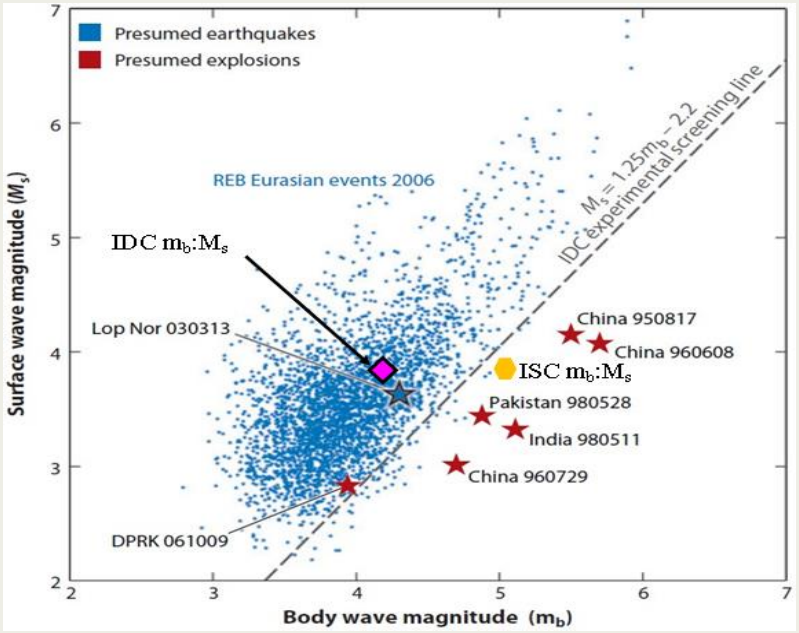

Figure 14: IDC and ISC m_b:M_s regression relationships for the triggering event in Bezores

Spectrograms from HA waveform data for HA stations H10N and H10S show three distinct events. Based on the epicentral location from analysis of seismic data, the polar plot and azimuth projection for H10N (Figure 13), the Bezores event corresponds to that having a BAZ = 346°.

The HA signal due to this event has an energy content ≥ -20 dB and maximum frequency of ~20 Hz, which characterize a T-phase at both H10N and H10S. The event in Bezores is therefore most likely a natural earthquake.

The third discrimination criteria is based on the focal mechanism solution determined using FOCMEC. For this purpose, additional waveforms data from non-IMS seismic stations was used. The focal mechanism solution (Figure 14) demonstrates that the earthquake in Bezores was caused by reverse faulting as opposed to an explosion. Based on the focal mechanism solution, the Bezores event is characterized as natural earthquake and no violation of the CTBT.

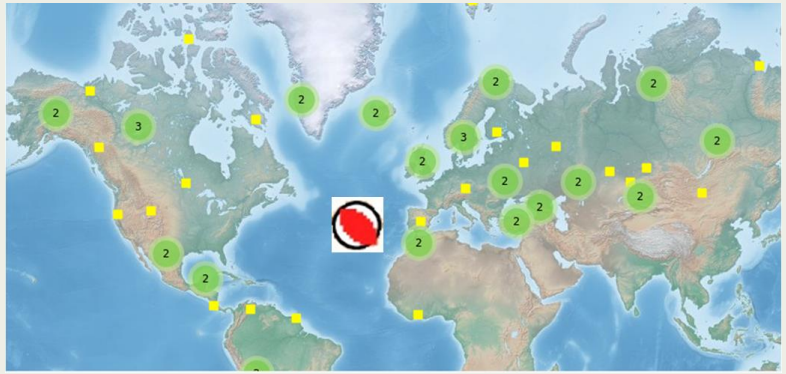

Figure 14: Focal mechanism solution of triggering event in Bezores