Enhancing Detection of Seismic Events through Data Integration of the Local Stations in the Jordan Seismological Observatory with CTBTO- IMS Network

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INTRODUCTION AND MAIN RESULTS

Integration data from the Jordan Seismological Observatory with the **CTBTO-IMS** network enhances the detection and location of earthquakes as well as explosions in Jordan and the surrounding region. According to a study of local and regional events – including an explosive event recorded by both seismic and infrasound stations, this integration resulted in:

- Improved event location accuracy and reduced azimuthal gap
- Enhanced detection of small events
- Integration of seismic observations with infrasound monitoring
- Strengthened national research capabilities using CTBTO tools

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Introduction

This study focuses on the importance of data integrating Jordanian national stations with the International Monitoring System (IMS) network of Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) in enhancing earthquake and explosion detection capabilities in Jordan. It includes analytical comparison of local and regional events between results that obtained from Jordan seismic network, and that obtained after adding data IMS seismic stations. The analysis aims to evaluate the locating accuracy of the events.

Also, this study will analyze an explosive event in Jordan or in nearby areas, then analyze the data obtained from some IMS infrasound stations that detected the same event using GPMCC Software and make comparison between them in order to achieve the most accurate results. In addition, this study will be used SeisComp and NDC-BOX. Fig, 1 and Table 1 show three earthquakes recorded at Gulf of Aqaba, Syria, and Cyprus. As well as one explosion at Dead Sea

Fig 1. Earthquakes (●) and explosion (●) locations recorded by Jordan Seismological Observatory stations A. Gulf of Aqaba, B. Syria, C. Cyprus

Methods/Data

1- Earthquake Analysis (Gulf of Aqaba, Syria, Cyprus)
Step 1 –analysis using Jordan Seismological Observatory Stations.
Step 2 –Re-analysis using Jordan Seismological Observatory stations and CTBTO-IMS stations.
Software: Geotool
Goal: Improved accuracy of earthquake location, Reduced Azimuthal Gap

2-Explosion Event Analysis
The event could not be located accurately using Jordan Seismological Observatory stations with SeisComP.
It was detected by four CTBTO infrasound stations.
Final analysis conducted with:
NDC-in-a-Box, GPMCC

Table 1. Earthquake and explosion events data and the stations that analyzed them

Event	Day and Time	Location	M	Jo. St.	IMS St.
Earthquake	2025-03-06 11:42:28	1. Gulf of Aqaba	4.2	JSO stations	ASF,EIL,MMA0
	2024-08-12 20:55:57	2. Syria	5.1		MLR,IDI,VRAC GNI,KVAR, VAEASF,EIL, MMA0
	2024-12-04 09:09:12	3. Cyprus	4.7		IDI,MLR,GNI, KVAR,ASF,EIL,MMA0
Explosion	2024-10-01 16:41:17	Dead Sea	-		infrasound stations: I19dj, I48tn, I32KE, I46RU

There are twenty three seismological stations distributed in Jordan as shown un Figure 2A. In addition Figure 2B shows IMS-CTBTO Stations

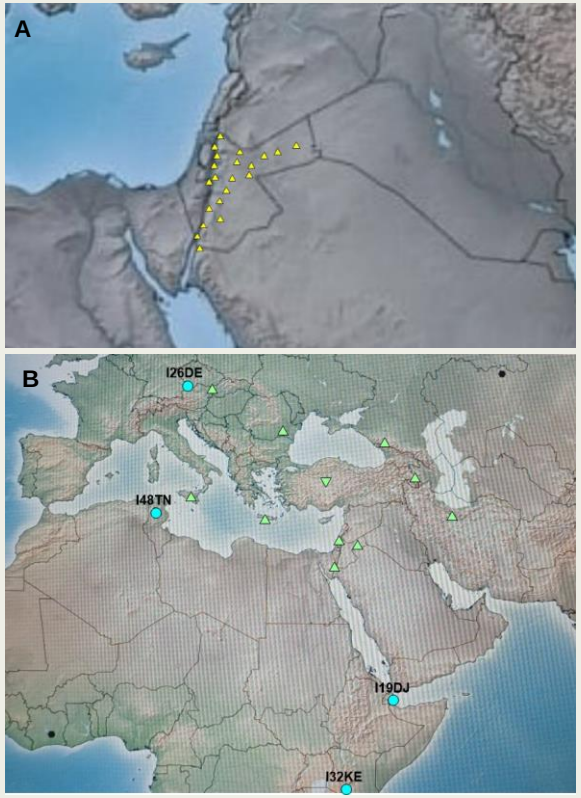

Fig 2. Seismic stations locations where **A**: Jordan Seismological Observatory Stations **B**: IMS-CTBTO Stations

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Results

This page shows a comparison between earthquake locations determined Jordanian station network and the results after integrating IMS stations. The aim of this is to assess the impact of integration on location accuracy and reduction of the Azimuth Gap.

Figs 3 & 4 show the analyses of three earthquakes at Gulf of Aqaba, Syria, and Cyprus by Jordanian stations and by Jordanian stations and CTBTO-IMS stations, respectively.
The results shown in Table 2 indicate that integrating IMS stations has improved the earthquake location accuracy and reduce gaps in seismic coverage in Cyprus and Syria. Regarding the earthquake at Gulf of Aqaba, the improvement in accuracy is not as good as in the other two places because the area covered by few stations. .

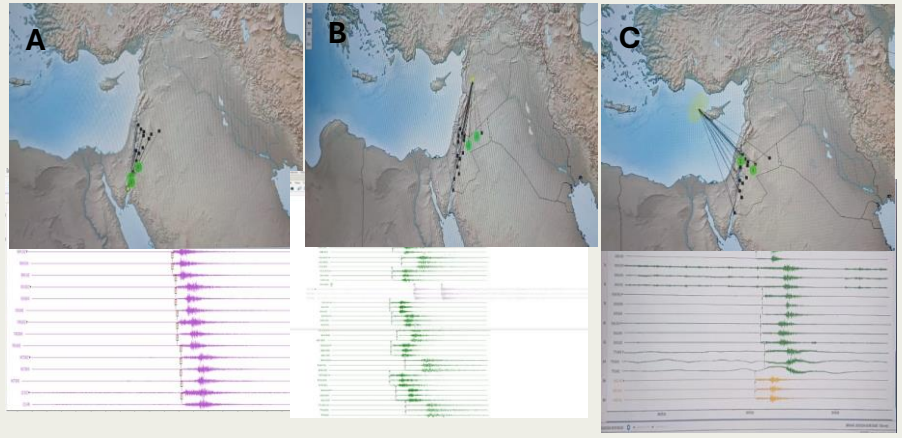

Fig 3. Earthquake Analysis by Jordanian stations (A. Gulf of Aqaba, B. Syria, C. Cyprus

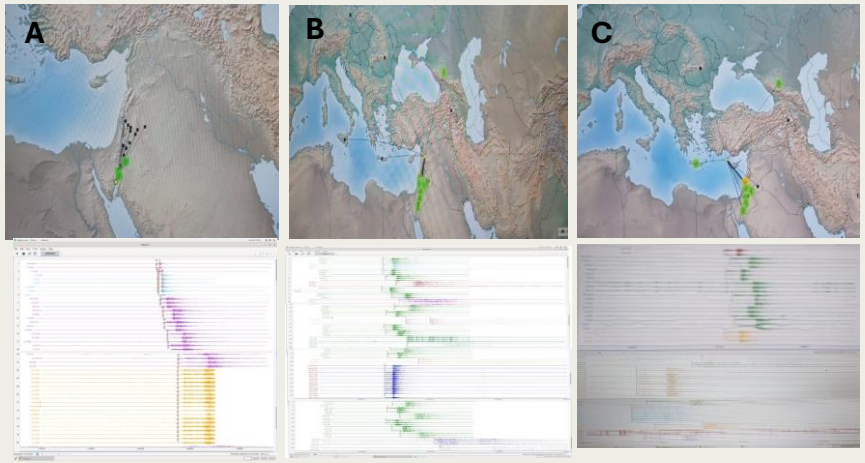

Fig 4. Earthquake Analysis by Jordanian stations and CTBTO-IMS stations (A. Gulf of Aqaba, B. Syria, C. Cyprus

Table 2. Comparison between JSO St. analysis and (JSO& IMS) St. analysis for the earthquakes at Gulf of Aqaba, Syria, and Cyprus

Day and Time	Event	Location (JSO)	Improved Location (JSO & IMS)	Azimuth Gap (JSO)	Improved Azimuth Gap (JSO & IMS)
2025-03-06 11:42:28	1. Gulf of Aqaba	29.2690N 35.4419E	29.0373N 34.7867E	332	255
2024-08-12 20:55:57	2. Syria	35.3290N 37.1167E	35.2903N 37.2200E	259	114
2024-12-04 09:09:12	3. Cyprus	35.6459N 31.6033E	35,9330N 31.7022E	321	111

Fig. 5 shows the wave of the earthquake at Gulf of Aqaba and Syria detected by Asfer station IMS. As well as the wave of the earthquake at Cyprus detected by IDI IMS station.

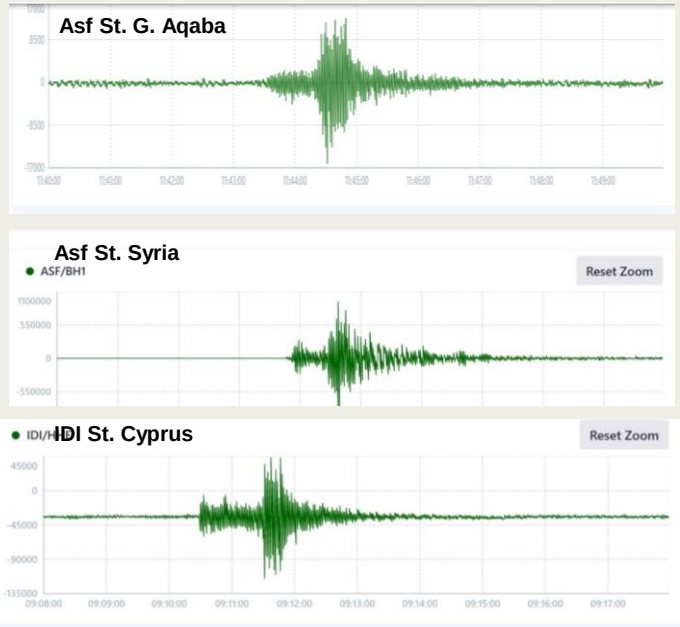

Fig 5. Waves of earthquakes at Gulf of Aqaba, Syria, and Cyprus

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Many Jordanian seismic stations recorded the explosion event at Dead Sea due to wars and conflicts in the region using the Seiscomp 4 software. The location is not precisely determined by that stations because the waves are interfering and noisy. Figure 6 shows the wave of the explosion detected by four selected stations: Azraq, Karama, Swaqa, Qirn stations.

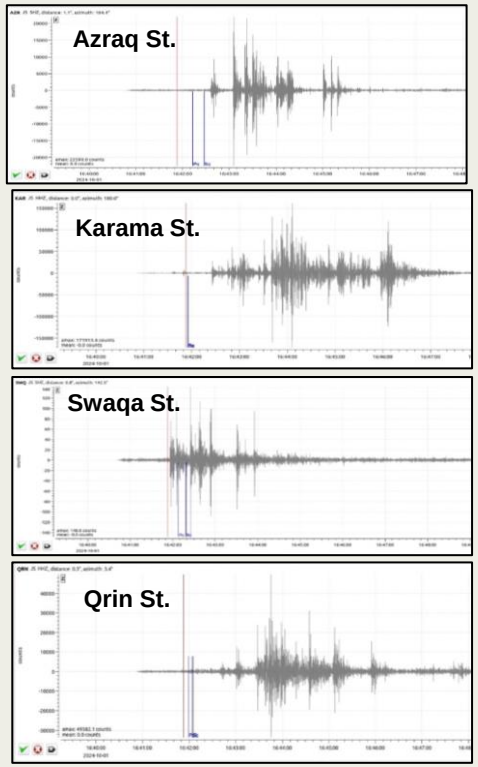

Fig 6. Explosion at Dead Sea Region detected by Jordanian Seismological Observatory station at 10-01-2024 using Sieiscomp 4 Software.

By checking the CTBTO WEB PORTAL Portal (REB Bulletins), it is noticed that the explosion event 26842681 Dead Sea Region- 16:41:17 detected by some infrasound stations: I19DJ, I48TN, I32KE, I26DE on October 1, 2024. (Fig. 7)

Fig 7.Record event by Ctbto Web Portal (REB Bulletins) 2024/10/1.

The data from infrasound stations; I19DJ, I48TN, I32KE, I26DE are analyzed using NDC-Box (GeoTool and GPMCC). One of them I26DE is selected in this poster as example as shown in Fig 8. Then the event location is determined on the (Fig 9)

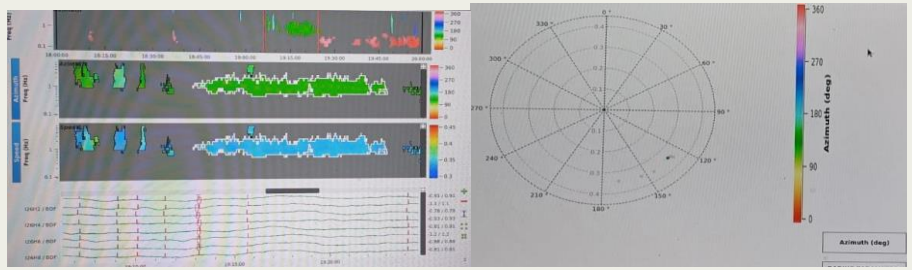

Fig 8.Wave form and back azimuth for I26DE Infrasound station by use GPMCC Software

Fig 9. location of Explosion at Dead Sea Region detected by IMS Infrasound stations at 10-01- 2024 4.

Conclusion

By combining information from the Jordan Seismological Observatory with the CTBTO-IMS network, earthquake and explosion detection and localization in Jordan and the surrounding area are improved. The integration led to Reduced azimuthal gap and increased event location accuracy, combining infrasound monitoring with seismic readings, and enhanced capacity for national research through the use of CTBTO resources

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