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Recent Magmatic Intrusion in the Southern Red Sea: May Be a Signal of the Formation of a New Volcanic Island

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Abstract

This study provides a comprehensive analysis of the recent volcanic seismic swarm in the southern Red Sea, specifically west of the Farasan Islands, southwest of Saudi Arabia. For a period of 7 days from July 29 to August 4, 2025, the Saudi National Seismic Network (SNSN) recorded over 300 minor earthquakes, with local magnitudes (ML) ranging from 1.65 to 4.7 within latitude 16.6147 and longitude 41.2075 (55 to 60 km west of the Farasan Islands). The swarm occurred in a vertical spreading at varying depths ranging from 4.5 to 30 km and included two earthquakes with local magnitudes of ML 4.33 and 4.7 at depths of 10 km and 13 km, respectively. The examination of the source mechanisms for the two largest earthquakes (ML = 4.3, 4.7) has revealed a normal mechanism that corresponds with the main direction of the Red Sea rift (northwest-southeast). Furthermore, the frequency contents of the majority of the swarm were measured at lower frequencies (below 1 Hz). According to the SNSN database, the recent swarm occurred in an area that had previously seen swarm activity and is located within a distance of 150 km from previous similar swarms that took place in 2007 and 2011 in the southern Red Sea. These similar swarms led to the formation of a new island on the northern edge of the Zubair Islands, which was called Al Jadid Island in 2011. The similarity between these swarms encompasses their number, depth range, vertical distribution, and eruption period to some extent. The results obtained indicated that the recent swarm is associated with volcanic activity, specifically a new magmatic intrusion that occurred beneath the middle of the southern Red Sea region. Thus, the possibility of the beginning of the formation of a new volcanic island in that location is raised. A hypothetical volcanic eruption scenario was developed, predicting heavy and light ash trajectories, potential threats to the Farasan Islands, south-

ern Saudi Arabia, and other neighboring countries as a whole.

Keywords

New Volcanic Activity, Southern Red Sea, Southwest of Saudi Arabia

1. Introduction

The Red Sea is regarded as a part of the continental rift system that stretches from the Dead Sea to Mozambique. Numerous geologists who have mapped its different sections have referred to it as the "Afro-Arabian Rift System" [1]-[3]. In conjunction with the Gulf of Aden, the Red Sea has been demonstrated to signify oceanic rifts at divergent plate boundaries, featuring a triple junction in the Afar Depression (**Figure 1**) [4]-[7]. Since that time, the utilization of plate tectonics has emerged as a key focus in the research of the Red Sea (**Figure 1**), as it illustrates a divergent tectonic boundary.

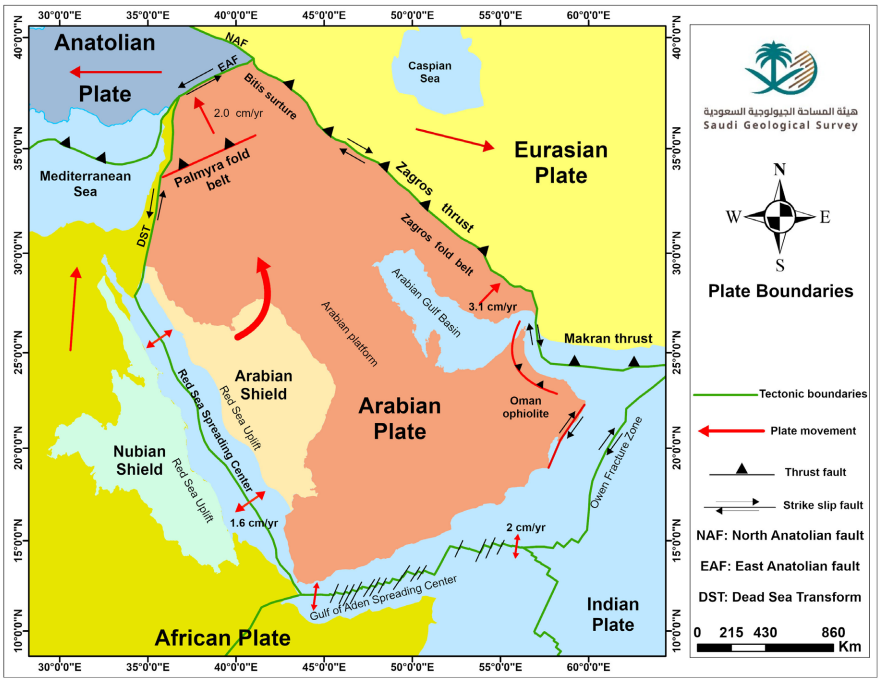


Figure 1. Map of the tectonic features of the Red Sea Rift System, which includes the Afar Rift in northern Ethiopia (East Africa), the Gulf of Aden, the Gulf of Aqaba, and the Gulf of Suez. The red arrows represent GPS velocities in a fixed Eurasian reference frame, as reported by [27]. The figure shows the location of the main rift (green solid line) in the central Red Sea (modified after [28]).

In 2007, a marked increase in seismic activity was observed in the southern Red Sea, prior to a volcanic eruption at Jabal Jazirat al-Tair. In addition, the Zubair Archipelago, located about 50 kilometers to the southeast on the southern Red Sea ridge, has experienced similar magma intrusions accompanied by earthquake

swarms over the past few decades [8]. At least six earthquake swarms have occurred over the past 20 years, likely caused by separate magma intrusions. Three of these, in 2007, 2011, and 2013, were followed by volcanic eruptions within a single year. The Zubair Archipelago nowadays consists of ten volcanic islands and several rocks located in the central part of the southern Red Sea ridge, between Yemen and Eritrea. These islands and rocks are approximately 100 meters high, 30 km long, and 10 km wide, and lie parallel to the Red Sea Mountain range [9].

Some volcanic eruptions are known to have occurred in the southern Red Sea on Jebel al-Tair Island and within the Zubair Archipelago in the 18th and 19th centuries. However, this activity was followed by more than a century of apparent calm until volcanic eruptions occurred at Jebel al-Tair in 2007 and 2008, and a few years later (2011) at Zubair Island, creating a new island (Al Jadid Island) [4] [9]. This island originated from an undersea eruption in December 2011, near Yemen's coast. The activity, located on the northern edge of the Zubair Islands, was captured by satellites and witnessed by Yemeni Navy helicopters, revealing violent explosions typical of shallow submarine eruptions [10]. **Table 1** represents the most recent and historical volcanic activities occurred in Southern Red Sea region.

This study analyzes a recent volcanic seismic swarm in the southern Red Sea, specifically west of the Farasan Islands, southwest of Saudi Arabia. From July 29 to August 4, 2025, the Saudi National Seismic Network recorded over 300 minor earthquakes with local magnitudes ranging from 1.65 to 4.7. The swarm occurred vertically at depths ranging from 4.5 to 30 km, including two earthquakes with local magnitudes of 4.33 and 4.7, respectively. By analyzing the data of this swarm, we conclude that this recent swarm is associated with volcanic activity, specifically a new magmatic intrusion that occurred beneath the middle of the southern Red Sea region. Thus, the possibility of the beginning of the formation of a new volcanic island is raised.

Table 1. Represents recent and historical volcanic activity in the southern Red Sea region, from [11].

Volcanic eruption	Height (m)	Location	Eruption date
Jebel Alzubair	191	15.05˚N 42.18˚E	2011-2012-2013
Jebel Al-Tair	244	15.55˚N 41.82˚E	2007-2008
Jebel Hanish	422	13.72˚N 42.73˚E	Holocene epoch
Jebel Zukur	624	14.02˚N 42.75˚E	Holocene epoch

2. Recent Seismic Swarm West of the Farasan Islands, Southern Red Sea

Seismic activity manifested as a swarm of earthquakes between July 29 and August 4, located to the west of the Farasan Islands in the southern Red Sea, southwest of Saudi Arabia. This swarm resulted in over 300 earthquakes, with magnitudes varying from 1.65 to 4.7 on the Richter scale (**Figure 2**). Among this seismic activity,

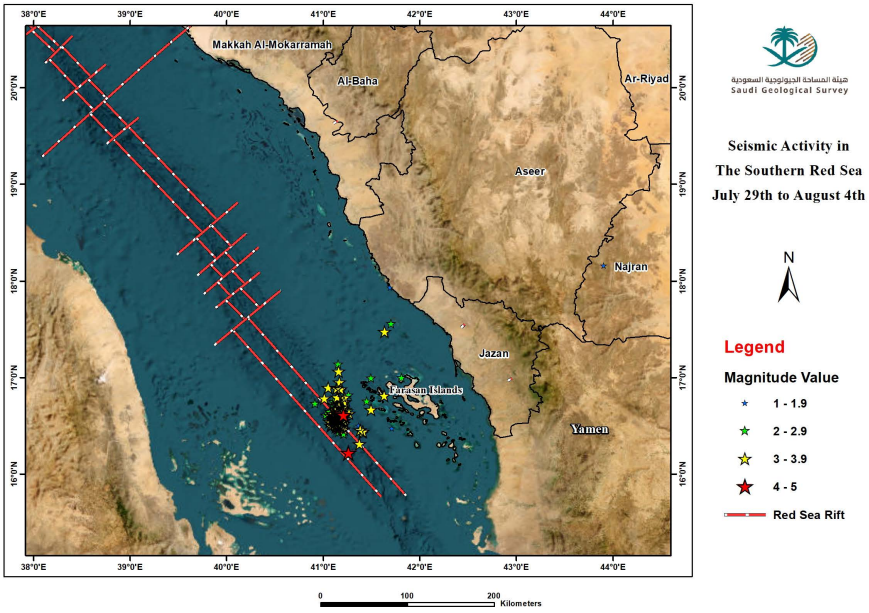


Figure 2. A map illustrating the recent seismic activity from July 29 to August 3, 2025, west of the Farasan Islands in the Jizan region, southwest of the Kingdom of Saudi Arabia. The stars of various colors represent the locations and seismic magnitudes of the seismic events, ranging from 1.5 to 4.24 on the Richter scale. (Source: National Geological Database, Saudi Geological Survey, SGS.)

two notable earthquakes occurred on the evening of Tuesday, July 29, with average magnitudes of 4.33 and 4.7 on the Richter scale. The first earthquake struck at 11:30 GMT (14:30 Saudi local time), followed by the second at 12:04 GMT (15:04 Saudi local time), occurring at depths of approximately 10 and 13 kilometers, respectively. **Figure 3** illustrates a recording from a seismic station belonging to the Saudi National Seismic Network (SNSN), (Farasan Island Station) pertaining to the second earthquake.

Shortly after the occurrence of these two earthquakes, the Saudi Geological Survey (SGS) was notified by several individuals who felt the earthquakes, with no reported losses or damage to the Farasan Islands. The appropriate authorities were alerted regarding the timing and magnitude of the earthquake, including the Saudi Civil Defense, which verified that there were no local damage reports in the immediate vicinity of the events, specifically the Farasan Islands, located very near this seismic activity.

The analysis of the seismic swarm showed that the activity extended in a near-vertical direction at different depths, with the deepest being at 30 km, and the shallowest occurring at approximately 4.5 km, as shown in **Figure 4**. The daily analysis during the period from July 29 to August 4 confirmed that the seismic swarm occurred in an almost uniform pattern, taking a vertical direction, as shown in **Figure 5**. The analysis may indicate that there is a reason behind the occurrence of this activity in this region, which is likely a volcanic magma intrusion into the southern Red Sea region, as this region is considered a volcanically active area, as occurred recently in the years 2007, 2011, and 2013, **Figure 6**.

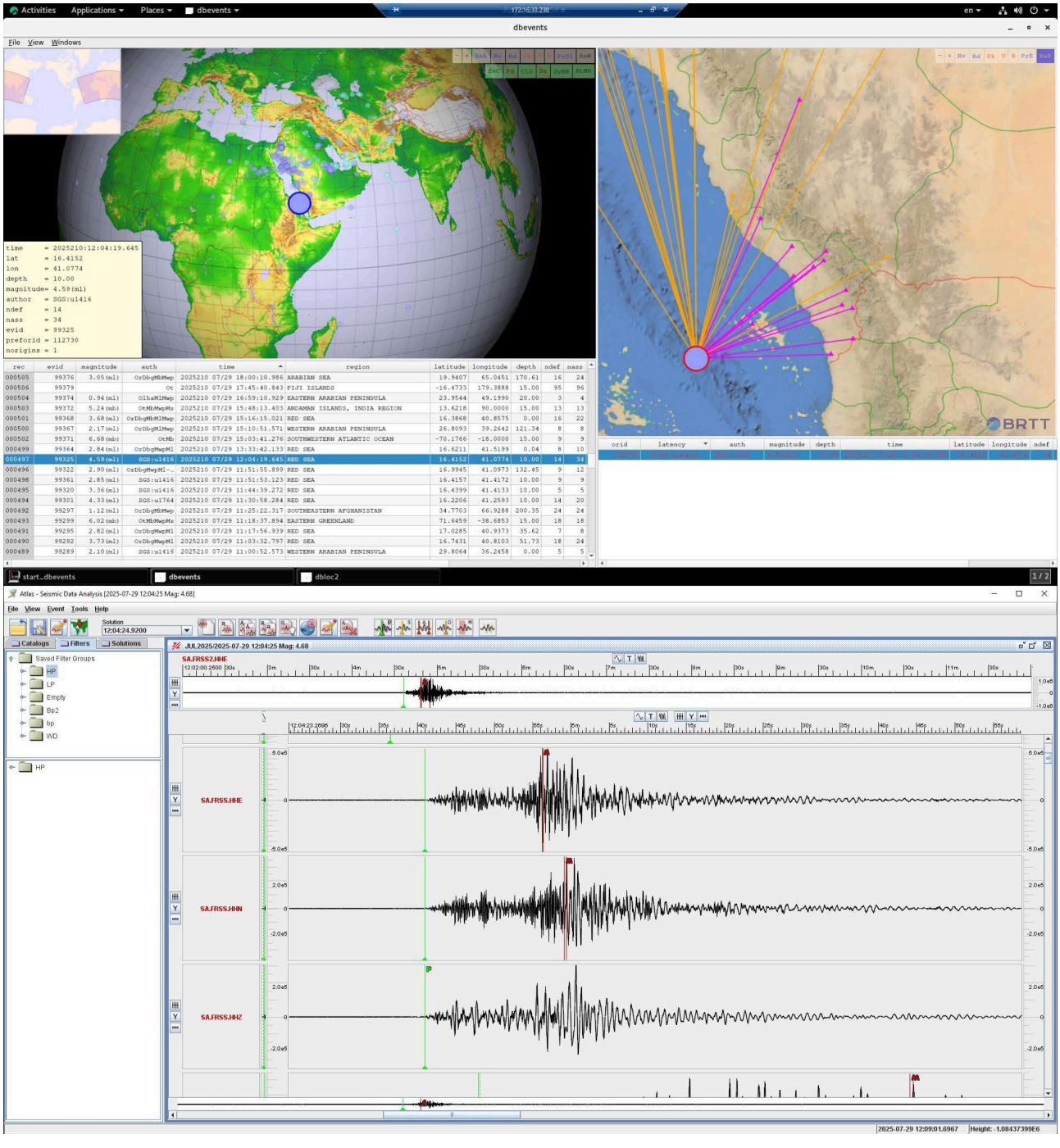


Figure 3. An image illustrates the location and recordings of the seismic monitoring station in the Farasan Islands for the earthquake that occurred on July 29, 2025, at 12:04 PM. The data were analyzed to determine the earthquake's location and depth, in addition to measuring its seismic magnitude using the seismic data analysis software (Antelope Software).

Basically, volcanic earthquakes typically result from the sudden opening of conduits in the Earth's crust, as well as rapid changes in magma flow, excessive buildup of gas pressure in the crust, and the collapse of the roofs of magma-expelling underground conduits. According to [12], volcanic earthquakes are classified into three groups: type A earthquakes, with epicenters between 1 and 10 km deep;

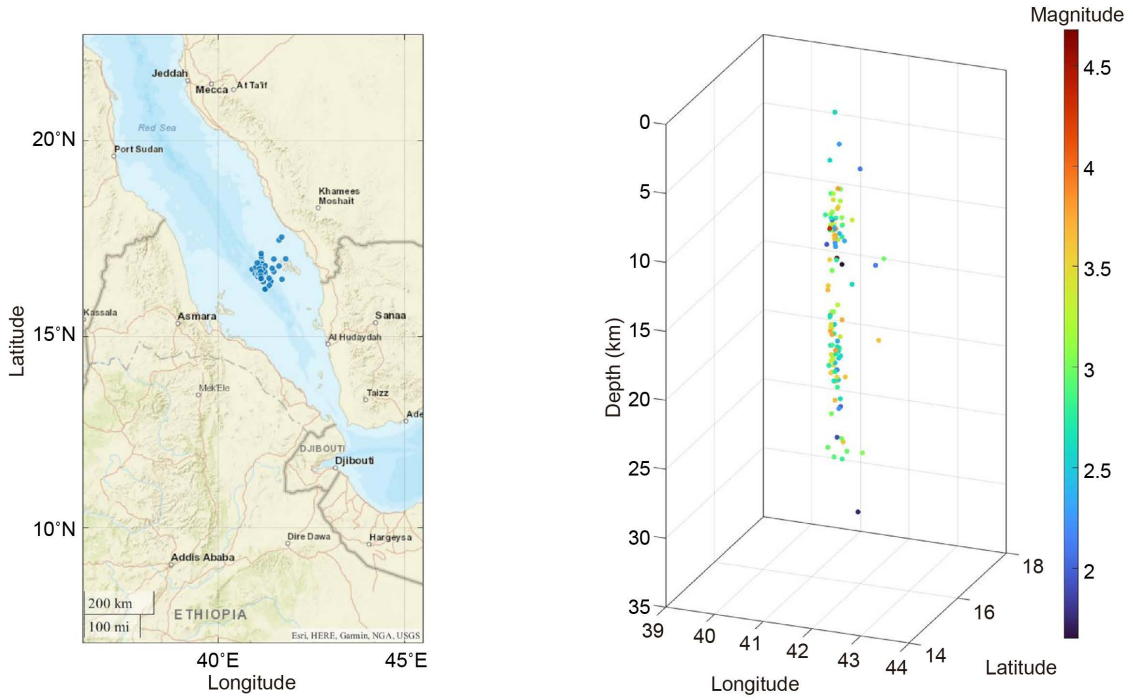


Figure 4. A map illustrating the recent seismic swarm that occurred in the southern Red Sea, to the west of the Farasan Islands, from July 29 to August 4, 2025 (left panel), along with a three-dimensional representation of the recent seismic activity (right panel). The figure illustrates the distribution of seismic activity in a nearly vertical direction, with circles of various colors representing the seismic magnitude of that activity, as indicated in the colored scale on the right side of the figure.

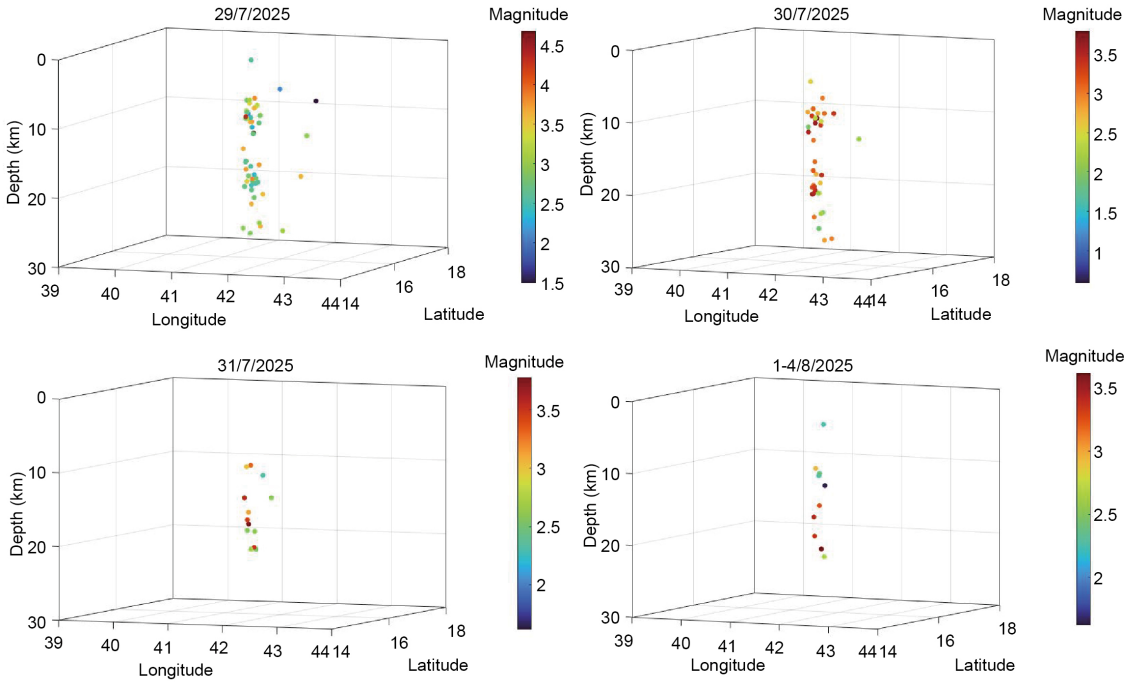


Figure 5. A 3D representation of the seismic swarm that took place in the southern Red Sea, to the west of the Farasan Islands, from July 29 to August 4, 2025. This model depicts the seismic activity on July 29, 30, and 31, along with the swarm occurrences on August 1, 2, 3, and 4, 2025. The figure shows the distribution of seismic activity in a nearly vertical direction, with the differently colored circles representing the seismic magnitude of that activity, as indicated in the colored scale on the right side of the figure.

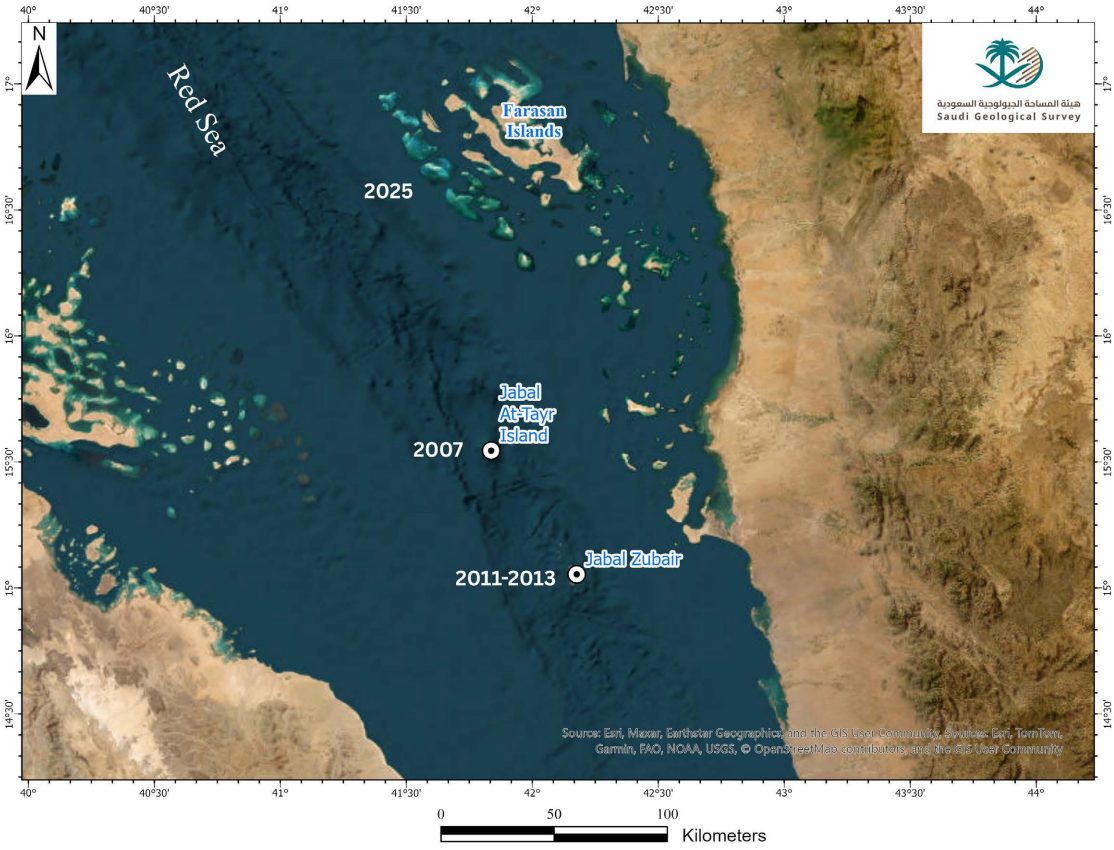


Figure 6. A map illustrating the southern Red Sea area, along with the islands located within it (Jabal al-Tair, AL Zubair, and the Farasan Islands), as well as a historical account of the earthquake swarm that took place in these islands during the years 2007, 2011, and 2013 at Jebel Al Tair and AL Zubair Islands, along with the recent swarm of earthquakes that occurred in July and August 2025.

type B earthquakes, with epicenters at a depth of 1 km or less; and explosive earthquakes, which occur on the Earth's surface. Another classification of volcanic earthquakes can be found in [13]. Near active volcanoes, we also observe what is known as volcanic tremors, which results from long-lasting and fairly continuous volcanic vibrations. While volcanic earthquakes are clearly isolated events, separated by time intervals, volcanic tremors exhibit rather jerky or harmonic behavior. These tremors are associated with subterranean magma flow, magma reservoir fluctuations, volcanic gas eruptions, etc., and are likely to be consistent with recent volcanic tremors that occurred west of the Farasan Islands during July-August 2025. Thus, we believe the recent swarm aligns with type A, as detailed by [12].

3. Discussions

3.1. Fault Plane Solutions of the Two Largest Events

The study of seismic source mechanisms aids in understanding how earthquakes occur and the movement along the fault surfaces responsible for their occurrence, where the earthquakes arise from sudden movements in the Earth's crust along

geological faults. [14] and [15] conducted research on seismic wave radiation, while [16] and [17] focused on scaling. Additionally, moment tensor analysis is elaborated upon by [18] and [19].

Results of source mechanisms by computing the moment tensors of the first event (ML = 4.33), as shown in **Figure 7**, showed that this event occurred as a result of a normal fault movement in the direction of the Red Sea extension. The seismic magnitude was also calculated on the moment magnitude scale, which reached 4.8 (Mw = 4.8), and the depth of the earthquake was accurately determined at approximately 10 km, as be shown in **Table 2**. For the second event (ML = 4.7), results showed that it also occurred as a result of a normal fault movement, typically like the movement of the first earthquake, and in the same direction as the Red Sea, **Figure 7**. The earthquake's magnitude of that event was calculated on the moment magnitude (Mw = 5.1), and it occurred at a depth of approximately 13 km.

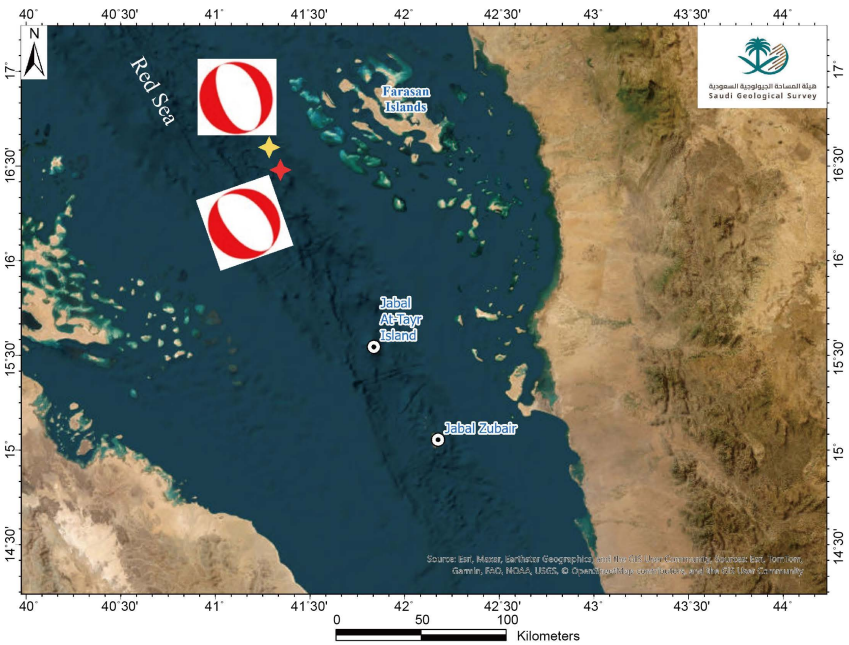


Figure 7. A map illustrating the locations of the two earthquakes that occurred on July 29, 2025, in the western part of the Farasan Islands in the Red Sea, southwest of the Kingdom of Saudi Arabia (the yellow and the white star, respectively), along with their movement mechanisms (the spheres in white and red), which reflect a natural movement in the direction of the Red Sea's extension.

Normal faults can form as a result of volcanic magma intruding out, especially in areas experiencing extension or rifting, such as the central Red Sea, particularly in its southern part. When magma rises and seeps into the Earth's crust, it creates a void that pushes the surrounding rocks upward and outward. This upward movement can cause extreme stress, leading to the formation of normal faults, where the upper block slides downward relative to the block below it [20]. These

findings suggest that the recent seismic swarm in the southern Red Sea is the result of volcanic magma intrusion into the Earth's crust from beneath the central Red Sea rift.

Table 2. Source parameters of the two largest events that occurred during the recent seismic swarm.

Event date	Time (UTC)	Saudi Local T.	Latitude	Longitude	Depth (km)	Mag. (Mw)
29/07/2025	11:31:05.3	08:31:05.3	16.476	41.288	10	4.8
29/07/2025	12:04:25.6	09:04:25.6	16.528	41.177	13	5.1

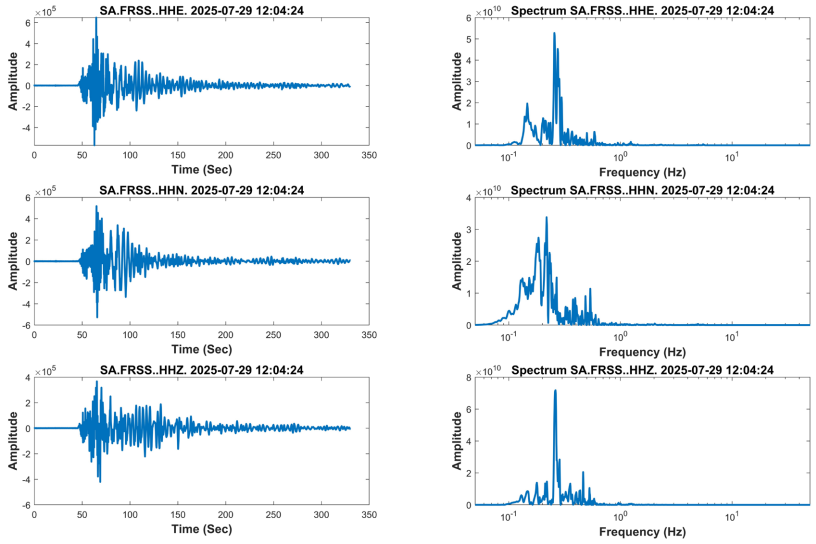
3.2. Frequency Contents

Frequency content refers to the distribution of a signal's or wave's amplitude across different frequencies and is often analyzed using techniques such as the Fast Fourier Transform (FFT) to understand the frequency components present in that wave. Seismic frequency content refers to the range of frequencies present in seismic waves generated by earthquakes. These frequencies vary widely, from very low (long-period ground oscillations) to high. Understanding frequency content is critical for analyzing the characteristics of earthquakes, predicting the effects of ground motion on structures, and determining the nature and causes of different types of seismic events.

Seismic waves generated by selected events that occurred on July 29, 2025, were used to determine the frequency content of these waves. Waveforms were used from four seismic stations belonging to the SNSN, two stations on the Farasan Islands very near to the locations of the recent swarm, and other stations far from the swarm located in the Jizan region, southwest of Saudi Arabia. The results showed that the frequency content of the seismic waves generated by these two earthquakes was measured at low frequencies of less than 1 Hz, as shown in **Figures 8(a)-(d)**.

Measuring these frequencies contributes to understanding the causes of earthquakes. Earthquakes that occur at low frequencies of less than or equal to 5 Hz indicate induced seismic activity, whether this activity is the result of human influences such as excessive withdrawal and injection of fluids from and within the Earth's interior. It could also be due to the intrusion of volcanic magma through a fault system within the Earth's crust, likely as occurred in our study area. Therefore, given that the recent earthquake swarm occurred in the southern Red Sea, specifically in the center of the ridge axis, it is likely that this swarm is the result of volcanic activity within the Red Sea's crust, similar to what occurred in previous years (2007, 2012, and 2013) on the Jabal Al-Tair and Zubair Islands in the southern Red Sea, respectively, which created new volcanic islands, (Al Jadid Island), [9].

[21]-[24] have examined the frequency characteristics of volcanic seismic swarms in different world areas and have reported that the frequency contents and spectra related to these volcanic activities were recorded at lower frequencies.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Spectrum SA.FRSS..HHE. 2025-07-29 12:04:24
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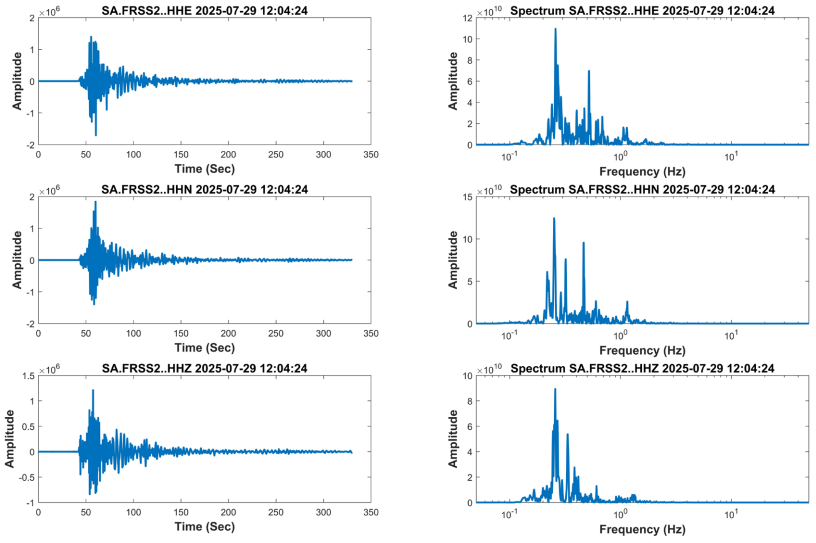
SA.FRSS..HHZ. 2025-07-29 12:04:24
Spectrum SA.FRSS..HHZ. 2025-07-29 12:04:24
Amplitude
Time (Sec)
Frequency (Hz)

(a)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Spectrum SA.FRSS2..HHN 2025-07-29 12:04:24
SA.FRSS2..HHZ 2025-07-29 12:04:24
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Amplitude
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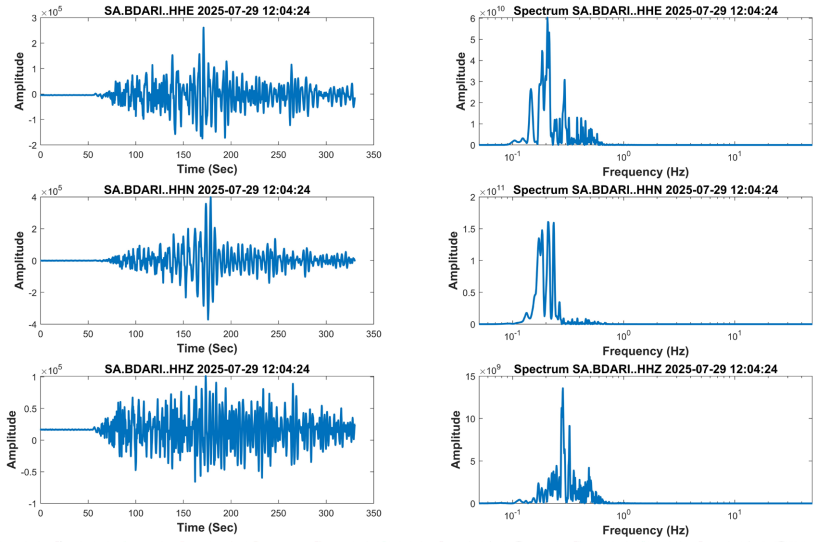
Frequency (Hz)

(b)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Spectrum SA.BDARI..HHE 2025-07-29 12:04:24
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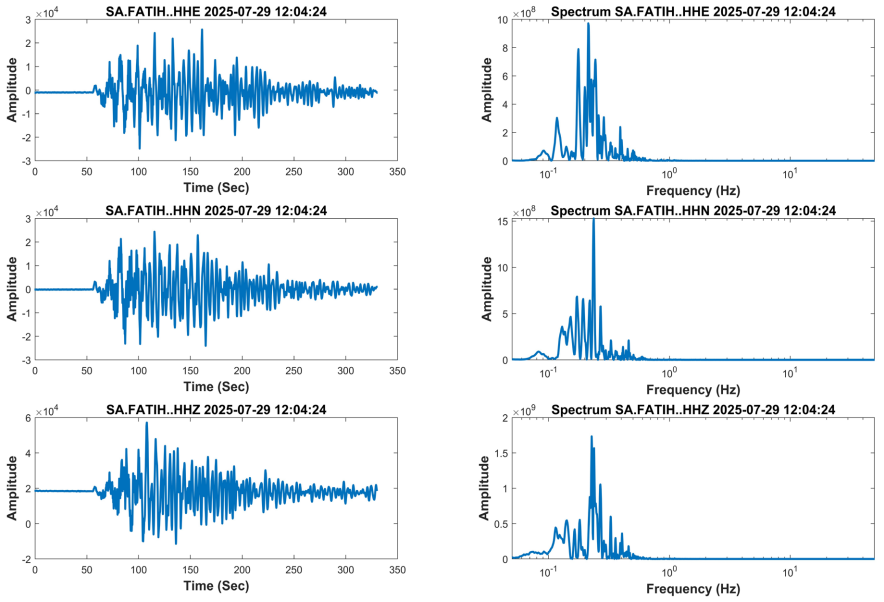
Spectrum SA.BDARI..HHN 2025-07-29 12:04:24
SA.BDARI..HHZ 2025-07-29 12:04:24
Spectrum SA.BDARI..HHZ 2025-07-29 12:04:24
Amplitude
Time (Sec)
Frequency (Hz)

(c)



(d)

Figure 8. (a) The frequency contents of the earthquake that occurred on July 29, 2025, at precisely 8:30 AM on a Tuesday, according to Saudi Arabian local time, are illustrated using the Farasan Island station. It is evident from the figure that the frequency was below 1 Hertz, which may indicate volcanic seismic activity. (b) The frequency content values for the same earthquake are illustrated using data from the Farasan Island 2 station (FRSN-2), with a frequency content of less than 1 Hertz as well. (c) continues, using data from the Badaria village station (BDARI), with a frequency content of less than 1 Hertz as well. (d) continues, using data from the Fatihi village station (FATIH), with a frequency content of less than 1 Hertz as well.

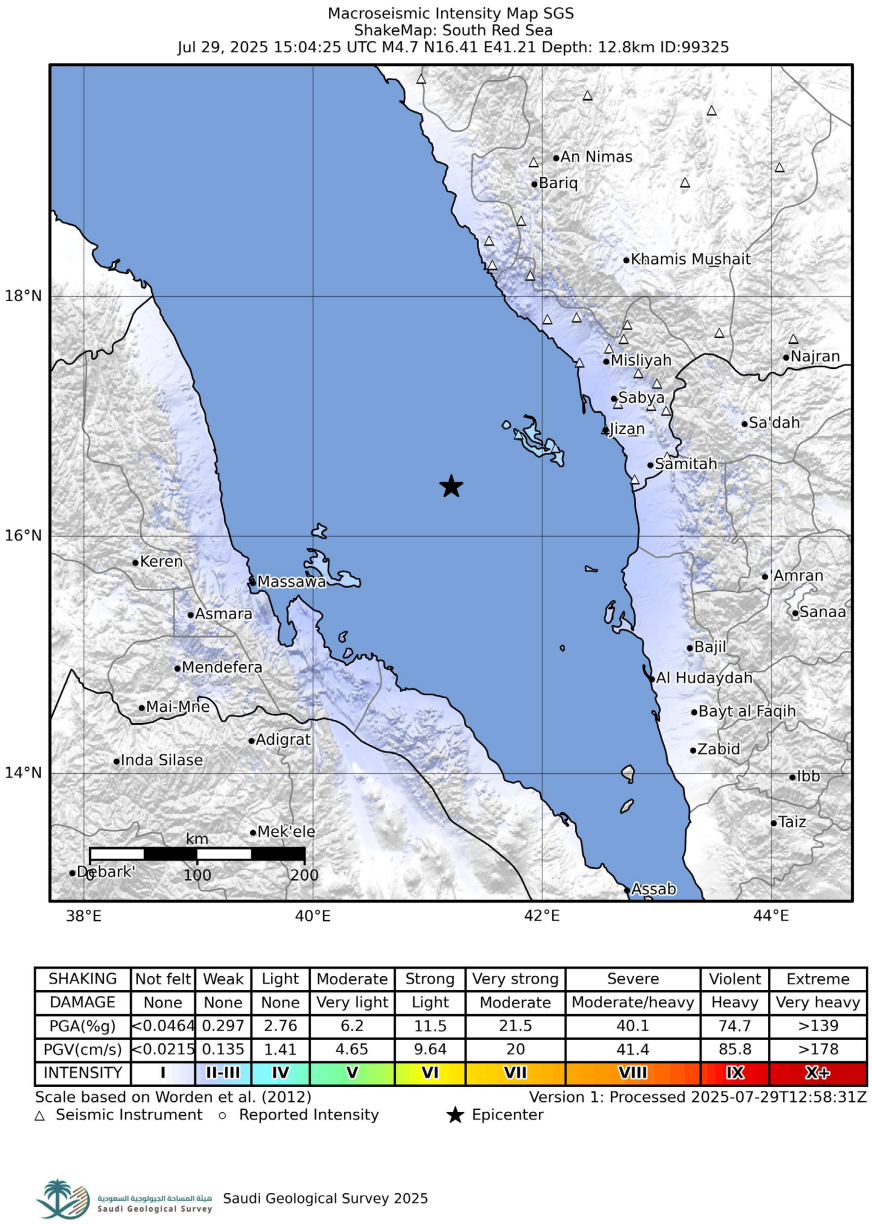
3.3. The Seismic Impact on the Farasan Islands (Southern Red Sea)

The National Program for Earthquakes and Volcanoes (NPEV) at the Geological Hazards Center has determined ShakeMap (digital maps that display the geographic distribution of the intensity of ground shaking resulting from a specific earthquake, based on real data from seismic monitoring stations). These display intensity levels through color gradations and indices, making it easier to clearly understand the earthquake's impact.

Based on the evaluation of the calculated seismic intensity values resulting from the two earthquakes with a local magnitude (ML = 4.33 and 4.7), the seismic intensity was weak as shown in **Figure 9**, and no impacts or damage were recorded on buildings and facilities in and around the Farasan Islands. The lack of impact might be due to the effect of seawater on the seismic waves. This was in coordination between the Seismic Observatory Operations Room of the Saudi Geological Survey (SGS) and the General Directorate of Saudi Civil Defense. No reports were received about any damage occurring.

3.4. Southern Red Sea Volcanic Activity

Volcanic activity in the southern Red Sea is associated with the Red Sea Rift, where



SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	None	None	None	Very light	Light	Moderate	Moderate/heavy	Heavy	Very heavy
PGA(%g)	<0.0464	0.297	2.76	6.2	11.5	21.5	40.1	74.7	>139
PGV(cm/s)	<0.0215	0.135	1.41	4.65	9.64	20	41.4	85.8	>178
INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Scale based on Worden et al. (2012) Version 1: Processed 2025-07-29T12:58:31Z
△ Seismic Instrument ○ Reported Intensity ★ Epicenter

هيئة المساحة الجيولوجية السعودية Saudi Geological Survey
Saudi Geological Survey 2025

Figure 9. A map illustrates an image from the seismic intensity report resulting from the earthquake on July 29, 2025, which includes information about the earthquake and its impact on the Farasan Islands and surrounding areas in the southern region of Jizan, located in the southwest of the Kingdom. The classification is based on the distance from the earthquake's epicenter. The various colors in the table represent differences in seismic intensity (National Program for Earthquakes and Volcanoes NPEV, SGS).

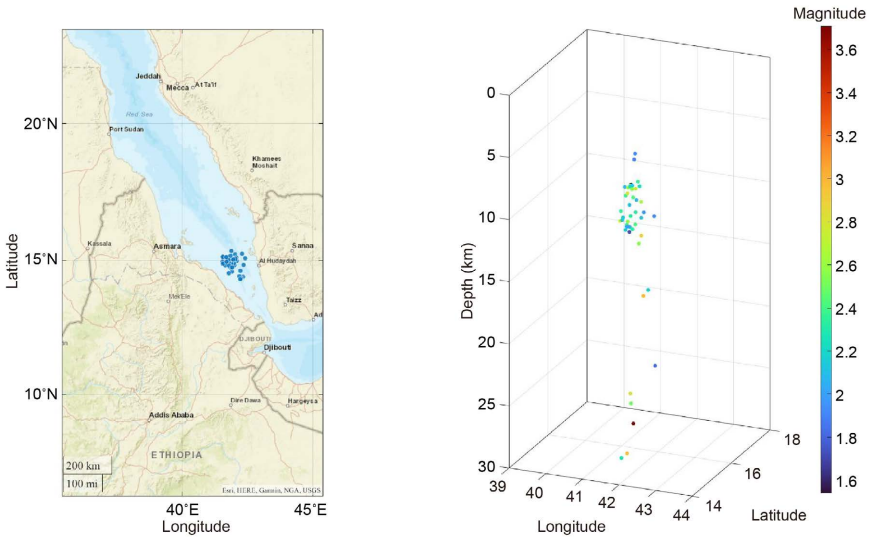
tectonic plates are moving apart, resulting in the formation of new volcanic islands. Recent volcanic eruptions have been documented, including those at Jabal Jazirat At-Tair in 2007 and at the Zubair Archipelago between 2011 and 2013, some of which formed new islands, **Figure 10**. These events indicate an ongoing cycle of rifting and significant volcanic activity in the region [9].

A marked increase in seismic activity (swarms) was observed in the southern

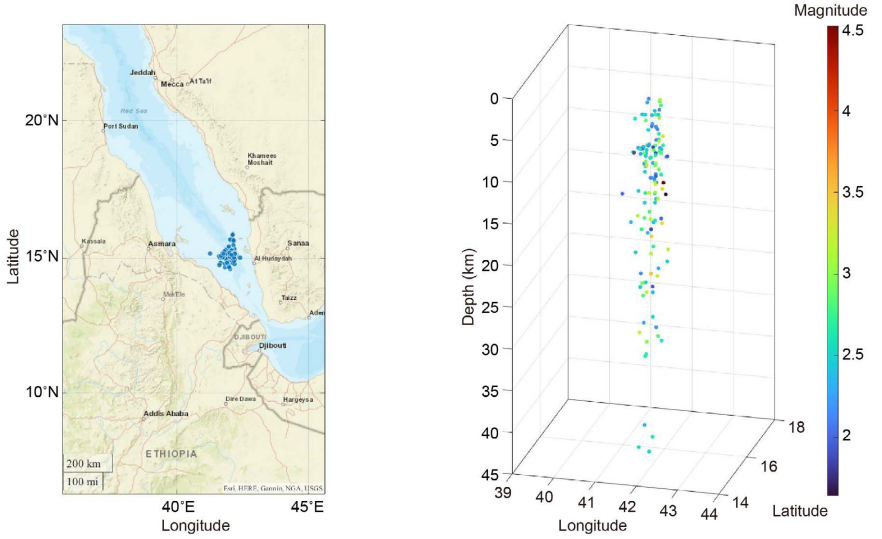
Red Sea in 2007, prior to a volcanic eruption at Jabal Jazirat at-Tair [8]. This eruption released lava and ash into the atmosphere. At least one lava flow entered the sea. [10] and [25] reported that 29 Yemeni soldiers were evacuated, but 8 remained unaccounted for. Several bodies were retrieved from the water, and the western section of the island, housing the military base, collapsed, as noted by.

Figure 10. An aerial image illustrating the volcanic eruption that occurred in December 2011 on the northern edge of the Zubair Islands in the southern Red Sea (red circle zone), which resulted in the formation of a new volcanic island (Al-Jadeed Island).

The Zubair Archipelago has experienced similar sequences of earthquake swarms over the past few decades. At least five earthquake swarms have occurred in the past 20 years, likely resulting from separate magmatic intrusions. In mid-December 2011, a new volcanic island formed (Al Jadid Island) in the Red Sea, approximately 60 kilometers (40 miles) off the western coast of Yemen, where an underwater volcanic eruption began, **Figure 10**. Local fishermen reported a volcanic eruption near Saba' Island, while satellites captured a white plume rising from the sea and a pulse of sulfur dioxide [10]. This volcanic eruption was associated with seismic swarm activity that took place on the northern boundary of the Zubair Islands, as noted by [8] and [9]. **Figure 11(a)** and **Figure 11(b)** illustrate the sites of volcanic activities that occurred in 2011 and 2013 at Zubair Island. **Figure 12** illustrates the recent seismic swarm that took place in 2025, alongside the earlier swarms that occurred in 2011 and 2013.



(a)



(b)

Figure 11. (a) A map showing the seismic swarms in the southern Red Sea region during the years 2007, 2008 (left panel), and the 3-D model of the swarm (right panel). It is evident that the distribution of these previous seismic swarms was vertical, similar to the distribution of the recent seismic swarm, indicating the intrusion of volcanic magma within the oceanic crust of the southern Red Sea area. (b) A map showing the seismic swarms in the southern Red Sea region during the years 2011, 2012, and 2013 (left panel), and the 3-D model of these swarms (right panel). It is evident that the distribution of these previous seismic swarms was vertical, similar to the distribution of the recent seismic swarm, indicating the intrusion of volcanic magma within the oceanic crust of the southern Red Sea area.

It is worth noting that some volcanic eruptions occurred at Jabal at-Tair and within the Zubair Archipelago during the eighteenth and nineteenth centuries [4]. However, this activity was followed by an apparent lull that lasted for more than a century, until volcanic eruptions occurred at Jabal al-Tair between 2007 and

2008, and a few years later in the Zubair Archipelago [26].

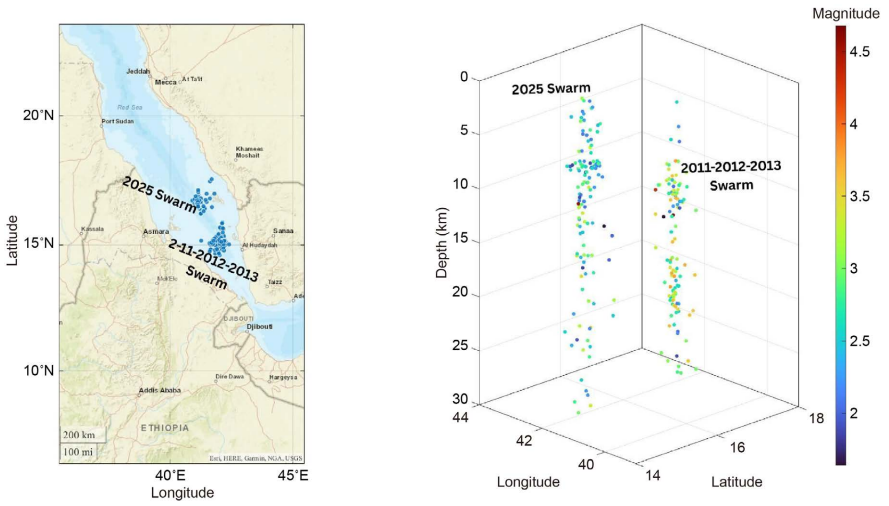


Figure 12. A map illustrates the locations of seismic swarms in the southern Red Sea region during the years 2011, 2012, and 2013 (with circles of varying sizes and colors), along with the most recent seismic swarm from 2025, and a three-dimensional representation of these seismic swarms (as shown in the figure on the right).

3.5. Volcano Eruption Scenario

To understand the expected impact of the volcanic eruption scenario, whether it involves the spread of light or deposited ash, based on wind speed and propagation in and around the recent seismic swarm, the software ASH3D [29] was used. The coordinates of the seismic swarm location were included, assuming a 2-hour eruption duration, an expected ashfall height of 10 km, and an estimated volume of 0.003 km^3. The specific parameters chosen were based on the events that occurred to some degree in 2007, as well as in 2011-2013 at Jebel At Tair and Zubair Island, respectively. The results showed that with the onset of the volcanic eruption (July 29, 2025), light volcanic ash carried by the wind began to cover a large part of the Farasan Islands, as shown in **Figure 13(a)**. On July 30, the ash flowed southeastward and northwestward, depending on the wind speed and direction, **Figure 13(b)**. Subsequently, on July 31, the volcanic ash covered the entire southern Red Sea region and a large part of the Republic of Sudan and Ethiopia, figure (13c). Then, on August 1 and 2, it moved northeastward, covering part of southwestern Saudi Arabia, as shown in **Figure 13(d)** and **Figure 13(e)**.

It should be noted that these results may give us a general idea of the direction of spread of light volcanic ash (which rises with the wind according to its direction). However, these results are for illustration purposes only and may differ from reality during a volcanic eruption. Keep in mind that these results are based on an assumption of a specific eruption duration (two hours) and an ash height (10 km), which may differ from actual eruption data.

Figure 14 illustrates the patterns of volcanically deposited ash (heavy ash) in the vicinity of the study area, with ash accumulating near the volcanic eruption

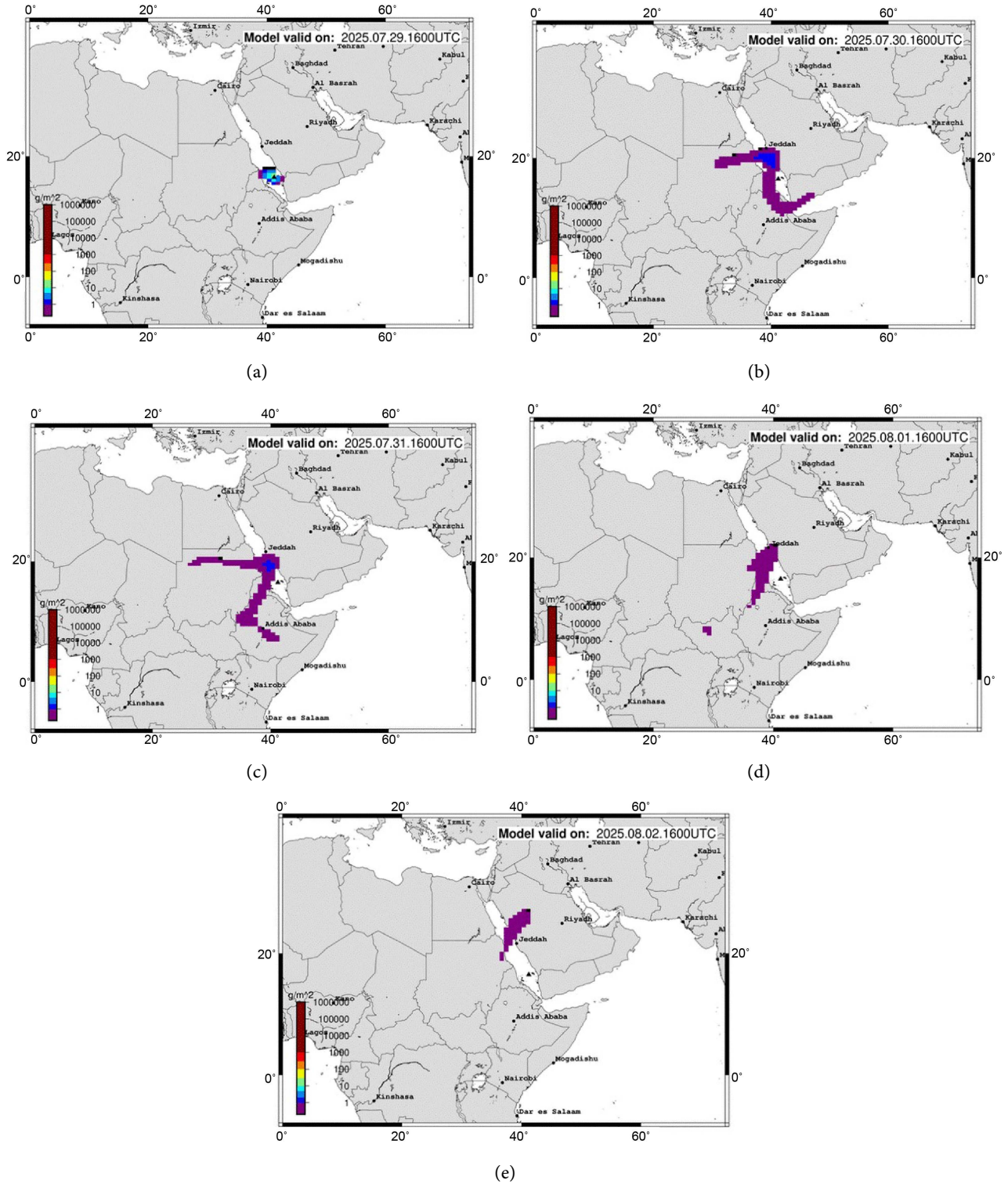


Figure 13. (a)-(e) A map illustrates the expected distribution of light volcanic ash resulting from a volcanic eruption scenario at the recent seismic swarm site west of the Farasan Islands in the Red Sea, occurring from July 29 to August 2, 2025. The figure above depicts the spread of volcanic ash on July 29, 2025, while the figures below show the ash distribution for the subsequent days, July 30, 31, and August 1 and 2, 2025. The figure indicates the areas that may be affected by volcanic ash in the event of an eruption at the Farasan Islands and the southern Red Sea region, as well as some cities in the southwest of Saudi Arabia, in addition to covering parts of neighboring countries such as Eritrea, Sudan, and a portion of Ethiopia.

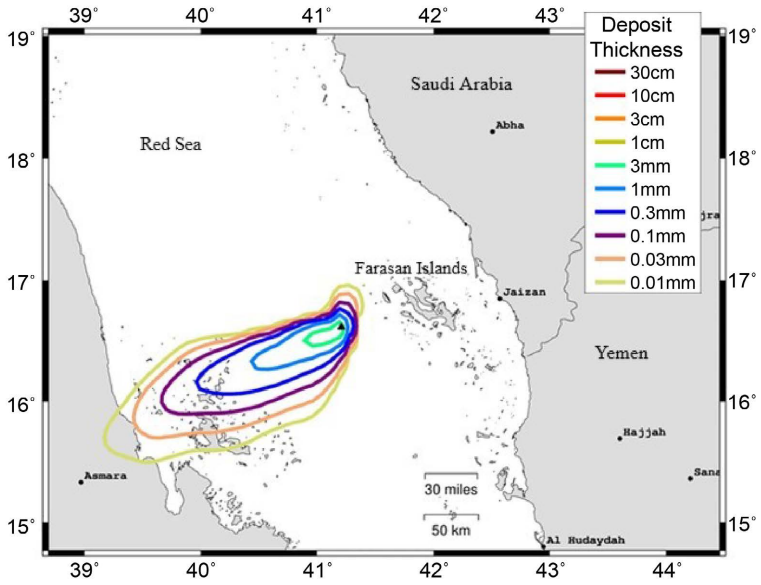


Figure 14. A map illustrates the direction of deposited heavy volcanic ash from the presumed volcanic eruption site, indicating its spread towards the southwest within the Red Sea, where it is completely distant from the locations of the Farasan Islands and the southwestern region of Saudi Arabia, specifically the Jizan region, meaning that no impacts are expected.

site due to its substantial weight and the prevailing wind direction. This significant accumulation of ash is directed towards the southwest of the anticipated eruption location. This suggests that the Farasan Islands, situated to the east of the scenario site and in a contrasting location, are significantly far from the deposition site and therefore do not pose a threat to the Farasan Islands.

4. Conclusions

In the southern region of the Red Sea, particularly located approximately 55 - 60 km west of the Farasan Islands, southwest of Saudi Arabia, an earthquake swarm occurred between July 29 and August 4, 2025. The depths of these events varied from about 4.5 to 30 km, with magnitudes ranging from 1.65 to 4.7, respectively. This swarm included two earthquakes that occurred on 29 July with a moderate magnitude exceeding 4 on the Richter scale, the first measuring ML = 4.33, and the second measuring ML = 4.7. The mechanisms of their occurrence were studied to understand their causes, and delineated normal movements trending typically in the same orientation as the Red Sea (northwest-southeast). The frequency contents of the seismic waves generated by some of these earthquakes were determined and measured at low frequency, less than 1 Hz.

A scenario was developed to predict a volcanic eruption at the site of the recent seismic swarm west of the Farasan Islands in the Red Sea, using the ASH3D (USGS) software. The scenario results showed the direction and spread of light and deposited ash, as well as the area expected to be covered by this ashfall, both in the Farasan Islands and in remote areas. The Farasan Islands, along with certain

regions in the southwestern part of Saudi Arabia, may be influenced by light ash, while remaining distant from the deposited ash. This indicates that the affected area is facing a "low risk of ash deposition." However, there may be a risk due to the spread of light volcanic ash, which could disrupt maritime navigation in the Jizan region of southwestern Saudi Arabia. Additionally, it may impact the marine environment surrounding the Farasan Islands, as well as pose health risks to the residents of those islands, such as respiratory issues and other related problems.

Following the examination of the recent seismic swarm, which includes 1) the vertical propagation of the seismic swarm; 2) the analysis of source mechanisms that indicated a normal movement trend along the trajectory of the Red Sea extension; 3) the identification of lower frequencies for certain selected events (below 1 Hz); and 4) the positioning of the swarm along the extension of the last eruptions that occurred in 2007, 2011, and 2013, it can be inferred that the primary cause of this recent seismic swarm is volcanic activity. This activity is linked to the intrusion of volcanic magma beneath the central Red Sea, which directly manifests as rifts that have ascended through the crust of the Red Sea, potentially leading to the formation of new islands in the future, similar to what happened in Jabal Jazirat At-Tair in 2007 and at the Zubair Archipelago between 2011 and 2013.

5. Recommendations

1. Expanding the quantity of seismic monitoring stations, ground acceleration measurement stations, and crustal deformation observation stations across the Red Sea islands to guarantee the surveillance of any seismic or volcanic occurrences and to evaluate their intensity. This, in turn, will contribute to the accurate monitoring of any seismic or volcanic activity that may occur in the Red Sea.

2. It is essential to exchange seismic data with countries on the west side of the Red Sea, from Egypt in the north to Eritrea in the south. This will help identify the locations of any seismic or volcanic activity that may occur in the Red Sea region, along the entire Red Sea from north to south, thus enhancing assessments of the severity of such activity and ways to mitigate these risks. Furthermore, enhancements in the study of seismic source mechanisms will be achieved.

3. Updating strategic emergency plans to mitigate the effects of volcanic activity is not limited to the Red Sea islands only, but also includes areas containing active volcanic lava fields within the Kingdom of Saudi Arabia.

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Article Highlights

Recent volcanic-seismic swarm in the southern Red Sea.

New magmatic intrusion.

Potential of the newly created volcanic Island.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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