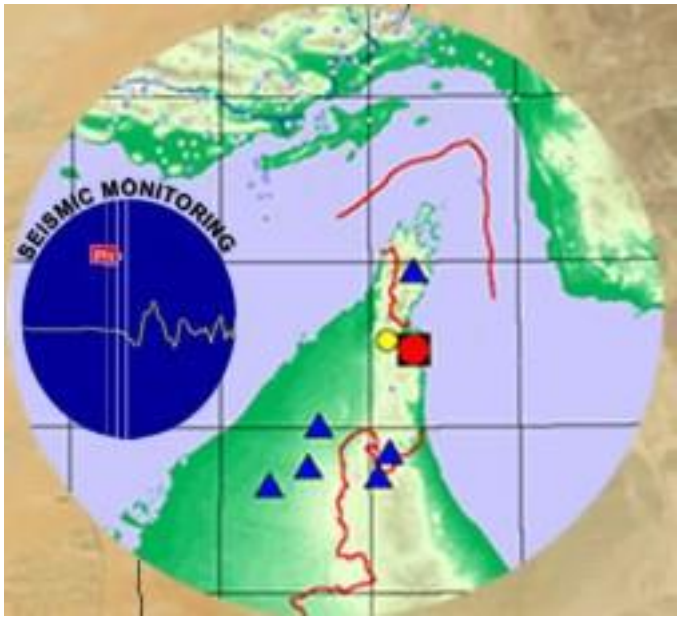
Bulletin of Dubai Seismic Network



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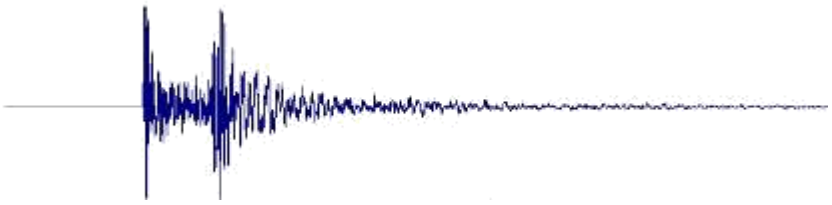

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Preface

Dubai Municipality installed the first earthquake monitoring system in UAE since April 2006, which consists of four broadband seismic stations to monitor the local and regional earthquakes which may have an effect on UAE and especially on Dubai Emirate. The earthquake information system provides support to the government organizations, Police and Civil defense in case of any felt earthquake in the region. Ongoing public awareness program for earthquakes and safety instructions is one of the Municipality contributions to the community services to reduce the earthquake hazard. The network is running properly, online data exchange between National Center of Metrology and Seismology of Abu Dhabi, neighboring countries (Oman and Kuwait) and the Global Digital Seismic Network is established which increases the detectability and aperture of the network.

On April 2012, Dubai Municipality installed 5 strong motion stations located closer to Dubai urban areas. These new stations support the automatic generation of ShakeMap that describe the extent of potentially damaging shaking following any effective earthquake. This project is a part from DM promotion to the disaster countermeasure of Dubai City for emergency response, loss estimation, and for public information through the media.

On June 2013, an independent backup server was installed at Umm Suqeim Dubai Municipality sub-center to acquire and analysis the earthquake data in case of any emergency in the main center at main building of Dubai Municipality.

While on December 2014, Structural Health Monitoring (SHM) System (24 strong motion channels) was installed on Rashid Tower (Dubai World Trade Center) to support the Enhanced Rapid Post-Event Assessment solution. While on June 2015, another SHM system (24 strong motion channels) was installed on Burj Khalifa.

On 2017, two SHM systems were installed on Dubai Municipality main building and Dubai Police Forensic Science and Criminology Building with 18 channels of strong motion sensors. All SHM systems were support by a smart application (DB-Safe/ OasisPlus for Dubai) to increase the safety of Dubai residences and to avoid the unnecessary evacuation during any felt event from southern Iran,

Although, Dubai Emirate own around 20% of high rise building around the world, Survey Department, Dubai Municipality start to monitor the effect of earthquakes on these towers for instantaneous support to the towers safety teams and building occupants with valuable data that showed any significant shaking above levels of human discomfort, how the building is influenced and how they can response in a smart way within very limited time.

The present bulletin is one of the products of the Dubai Seismic Network.

Mohammed Mahmoud Mashroom

Director of Survey Department

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CONFIGURATION OF DUBAI SEISMIC NETWORK (DSN)

The seismic monitoring system consists of a central processing unit (CPU) located in the Survey Department, Dubai Municipality, which receives seismic data from four seismic stations via 4 hybrid communication links consisting of spread-spectrum Ethernet radios and digital lease lines as well as an end user provided internet access for real time data exchange **(Fig. 1)**. The remote station consists of a 6-channel high resolution, IP-aware digitizer (Q330), a broad-band seismometer (STS-2) and a force balance accelerometer (ES-T). **Table 1** shows the name, code, and coordinate of the stations. The digitizer converts the analog seismic signal to digital data at 100, 20 and 1 sample/second. **Figure 2** shows the Dubai seismic monitoring system drawing overview. The network is completely based on TCP/IP communication which allows reliable data acquisition and control of the remote sites from the data center. ANTELOPE software (5.8) is used for data acquisition and analysis.

The real-time system exchanges data via the orb-exchange-protocol to and from the Earthquake Monitoring Center **(EMC)** of Oman and Kuwait National Seismic Network **(KNSN)** which improves the detection and location accuracy of local and regional earthquake in the region. Real time data exchange between Dubai Seismic Network **(DSN)** and NCMS is done through seed link-orb-protocol. All of these real time data enhance the detectability of smaller earthquakes and help to delineate the active faults in northern UAE.

Besides these local and regional stations from neighboring centers and countries, few broadband stations from the Digital Global Seismic Network **(Fig. 3)** were also added to the DSN database to increase the efficiency and detectability of the DSN network for remote and teleseismic events in real time. The parameters of regional and global seismic stations recorded in real time by DSN center are listed in **Table 2.**

On April 2012, Dubai Municipality installed 5 strong motion stations **(Fig. 2)** located closer to Dubai urban areas. These stations sent their digital records to DSN via GPRS technology. The locations of these stations (**Table 1)** are selected to cover most of the urban area and to reflect the ground motion response for different soils beneath Dubai urban area. The shake maps for the earthquakes are automatically generated according to their magnitudes (local events ML > 3 and regional events mb> 5) on real time after the occurrence of the events by less than 5 minutes and published on Geodesy & Hydrographic Survey Section, Survey Department, Dubai Municipality web site.

This quick, accurate and important information can aid in making the most effective use of emergency-response resources, loss estimation and for public information through the media.

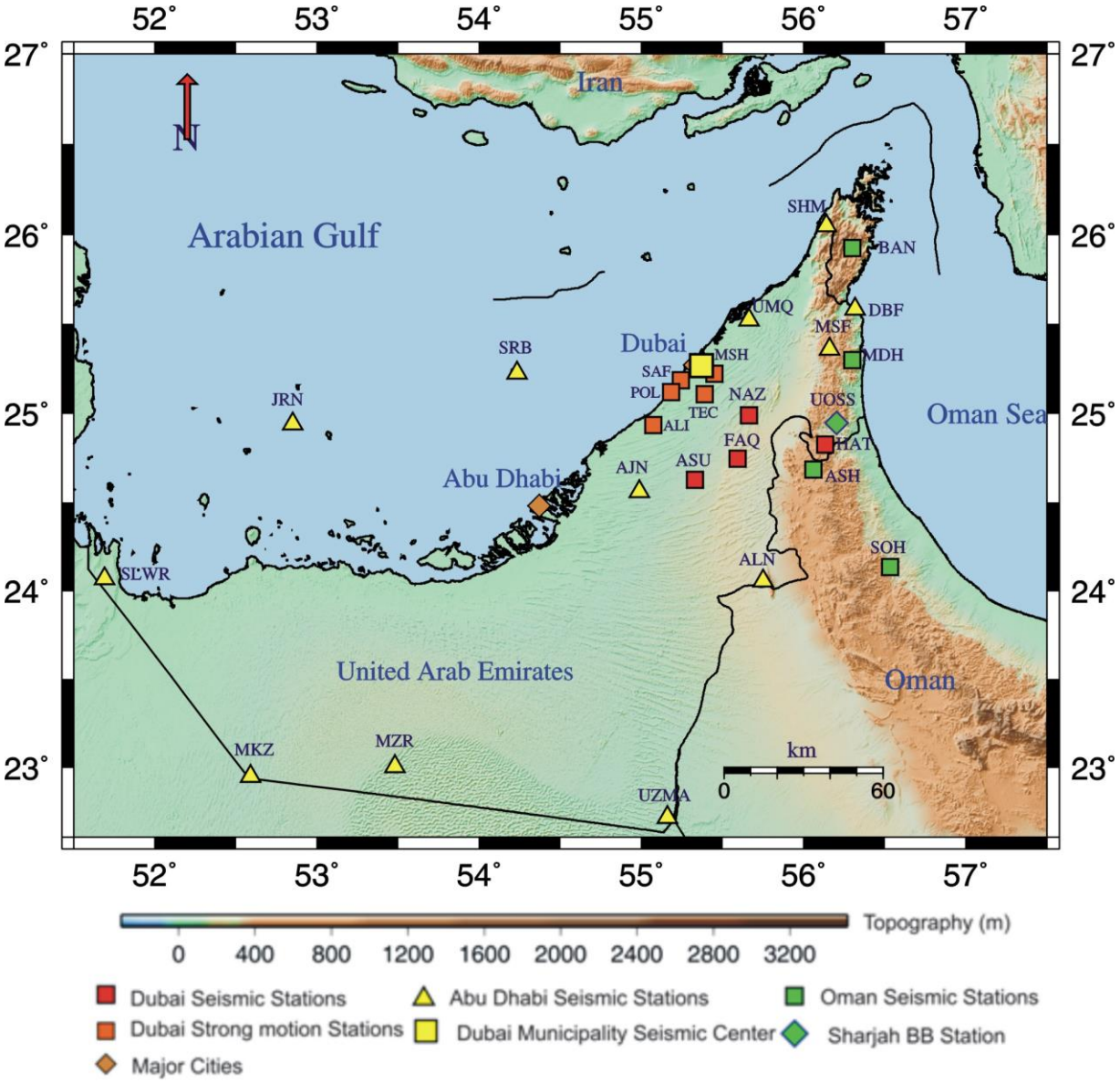

Figure 1. Permanent local broadband seismic stations that send their data to Dubai Municipality Seismic Center.

Table 1. Locations of Dubai Municipality Seismic Stations (DSN).

No.	Station Name	Code	Latitude (N°)	Longitude (E°)	Elevation (Km)	Sensor Type
1	Hatta	HAT	24.8257	56.1321	0.3401	STS-2 & ES-T
2	Nazwa	NAZ	24.9884	55.6618	0.1988	STS-2 & ES-T
3	Al-Faqqa	FAQ	24.7453	55.5924	0.2035	STS-2 & ES-T
4	Al-Ashush	ASU	24.6260	55.3292	0.1322	STS-2 & ES-T
5	Jabel Ali	ALI	24.9329	55.0744	0.0150	BASALT
6	Mushref Park	MSH	25.2223	55.4506	0.0070	BASALT
7	Safa Park	SAF	25.1865	55.2420	0.0160	BASALT
8	Technical College	TEC	25.1073	55.3894	0.0140	BASALT
9	Police Academy	POL	25.1200	55.1826	0.0130	BASALT

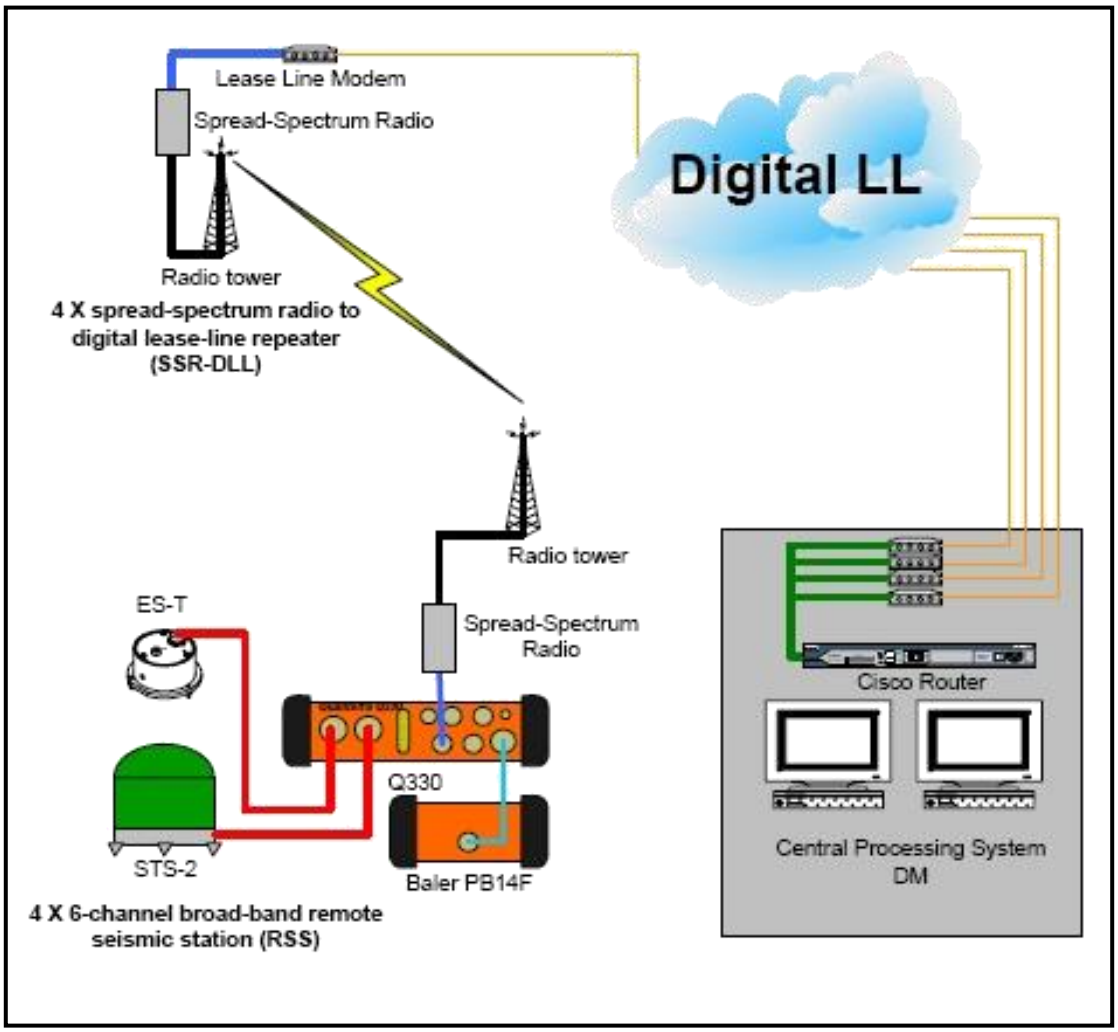

Figure 2. Overview of the Seismic Monitoring system

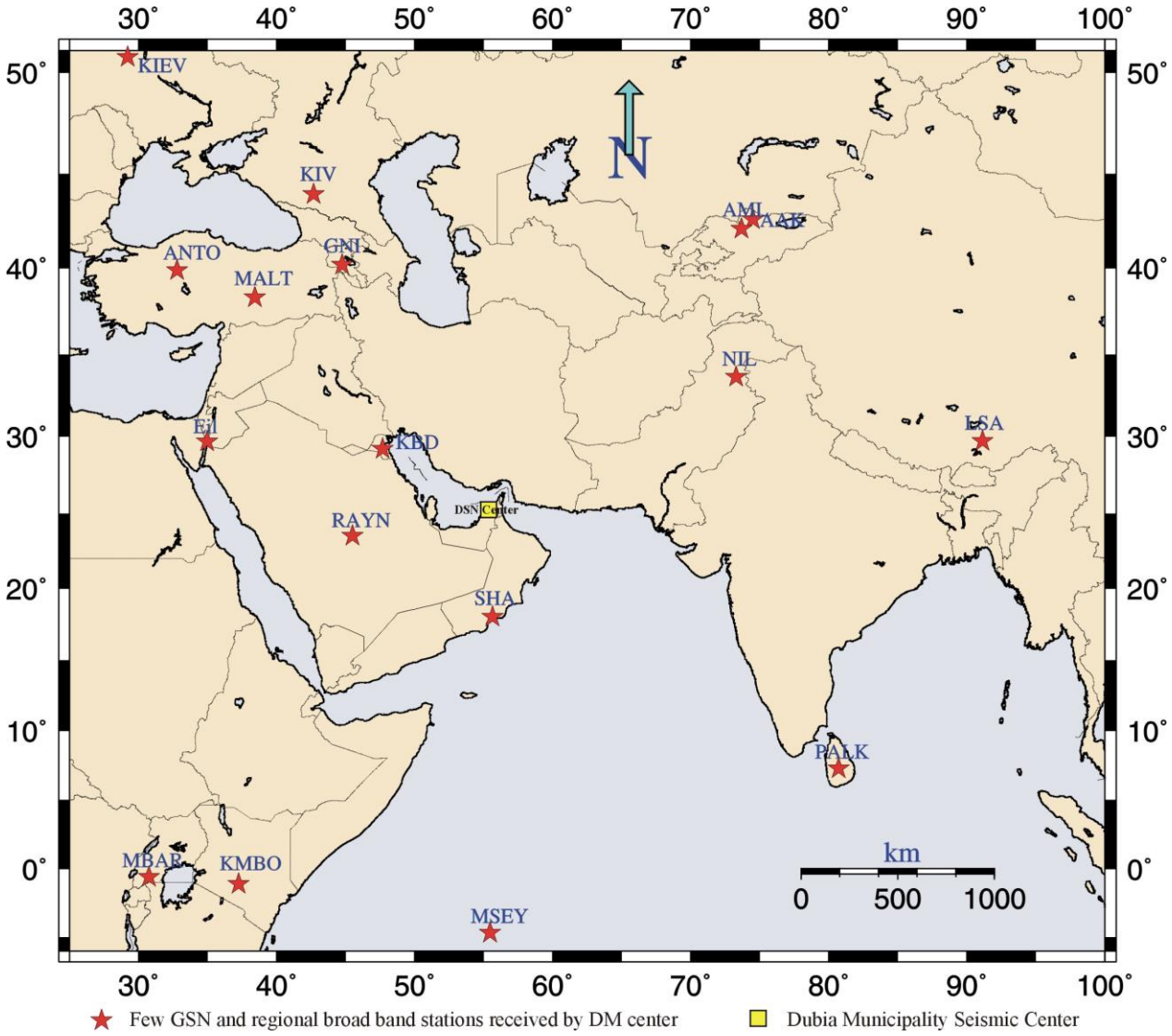

Figure 3. Geographic distributions of seismic stations from the neighboring countries and the Global Digital Seismic Network.

Table 2. Parameters of the local, regional and global seismic stations received by DSN.

No.	Station Name	Code	Lat.	Long.	Elevation (km)
1	Al Ain, Abu Dhabi	ALN	24.0561	55.7509	0.3420
2	Ajban, Abu Dhabi	AJN	24.5626	54.9865	0.0670
3	Esma-Masafi, Abu Dhabi	MSF	25.3596	56.1595	0.5240
4	Umm Al-Quwin, Abu Dhabi	UMQ	25.5252	55.6623	0.0280
	Muzera, Abu Dhabi	MZR	23.0024	53.4794	0.3000
6	Shamm, Abu Dhabi	SHM	26.0490	56.1413	0.5240
7	Ashyiah, Oman	ASH	24.6839	56.0583	0.5460
8	Banah, Oman	BAN	25.9233	56.2996	0.5040
9	Shalim, Oman	SHA	18.0228	55.6251	0.2920
	Madha, Musandam Region, Oman	MDH	25.2987	56.2983	0.1850
11	Sohar, Al Batinah Region, Oman	SOH	24.1342	56.5336	0.1000
12	University of Sharjah, UAE	UOSS	24.9453	56.2042	0.2830
13	Nilore, Pakistan	NIL	33.6506	73.2686	0.6290
14	Ala-Archa, Kyrgyzstan	AAK	42.6390	74.4940	0.3960
15	GEOFON/MedNet Station Malatya, Turkey	MALT	38.3134	38.4273	1.1200
16	Garni, Armenia	GNI	40.1480	44.7410	1.6090
17	Almayashu, Kyrgyzstan	AML	42.1311	73.6941	3.4000
18	Kislovodsk, Russia	KIV	43.9553	42.6863	1.0540
19	Mbarara, Uganda	MBAR	-0.6019	30.7382	1.3900
	Mahe, Seychelles	MSEY	-4.6737	55.4792	0.4750
21	Pallekele, Sri Lanka	PALK	7.2728	80.7022	0.4600
22	Tibet, China	LSA	29.7000	91.1500	3.7890
23	Al Kabd, Kuwait	KBD	29.1756	47.6933	0.1240
24	Kilima Mbogo , Kenya	KMBO	-1.1271	37.2525	1.9500
25	Kiev, Ukraine	KIEV	50.7012	29.2242	0.1800
27	Elat, Eilat, Israel	EIL	29.6699	34.9512	0.210
28	Ankara, Turkey	ANTO	39.8680	32.7934	1.090
29	Ar Rayn, Riyadh, Saudi Arabia	RAYN	23.5225	45.5032	0.631
	Sila, United Arab Emirates	SLWR	24.0696	51.6913	0.0100
31	UM Zumoul, United Arab Emirates	UMZA	22.7138	55.1609	0.0100
32	Sir Bunair, United Arab Emirates	SRB	25.2268	54.2341	0.0100
33	Jarnain, United Arab Emirates	JRN	24.9420	52.8495	0.0100
34	Dibba- Fuiairah, UAE	DBF	25.5831	56.3165	0.063
	Mukherz, UAE	MKZ	22.9465	52.5901	0.101
36	Sir Bunair, UAE	SRB	25.2268	54.2341	0.000
38	Wanagama, Indonesia	UGM	-7.9125	110.5231	0.350

MAGNITUDE CALCULATION

Local Magnitude is estimated according to Richter magnitude by ORBMAG program. Each waveform segment is converted to equivalent drum recorder displacement of a standard Wood-Anderson instrument and the maximum amplitude for the event is determined. These amplitudes are fed into the standard Richter magnitude formula for computing ml values for each station and all of the station ml values are median averaged to get a total network M_L estimate.

Body wave (Mb) and surface wave (Ms) magnitudes are estimated according to the general formulas within ANTELOPE software:

$$Mb = \log_{10}(amp) + 1.66 \log_{10}(\Delta) - 0.104$$

$$Ms = \log_{10}(amp) + 1.66 \log_{10}(\Delta) - \log_{10}(\Delta*0.0097+9) + 0.52$$

Where Δ: distance between source and receiver in degrees.

DUBAI STRUCTURAL HEALTH MONITORING (SHM) SYSTEM

On December 2014, DM installed 24 strong motion channel sensor on Rashid Tower-Dubai World Trade Center **(Fig. 4)** to manage the Post-Event Assessment Solution. The primary objective is to prevent unwarranted distress among Dubai citizens and unnecessary business interruption caused by unwarranted evacuations, and to minimize periods of downtime waiting for an official decision to reoccupy. A similar system was installed on Burj Khalifa on June 2015 **(Fig. 5).** While, on 2017 two SHM systems were installed on Dubai Municipality main building and Dubai Police forensic science and criminology building with 18 channels of strong motion sensors. All SHM systems were support by a smart application (DB-Safe/ OasisPlus for Dubai) to increase the safety of Dubai residences and to avoid the unnecessary evacuation during any felt event from southern Iran. Dubai Emirate own around 20% of high rise building around the world, Survey Department, Dubai Municipality start to monitor the effect of earthquakes on these towers for instantaneous support to the towers safety teams and building occupants with valuable data that showed any significant shaking above levels of human discomfort, how the building is influenced and how they can response in a smart way within very limited time **(Figs. 6, 7).** Also, the smart application supports the public residents away of these towers by all earthquake information and safety tips and receive their feedbacks and comments to develop this smart application.

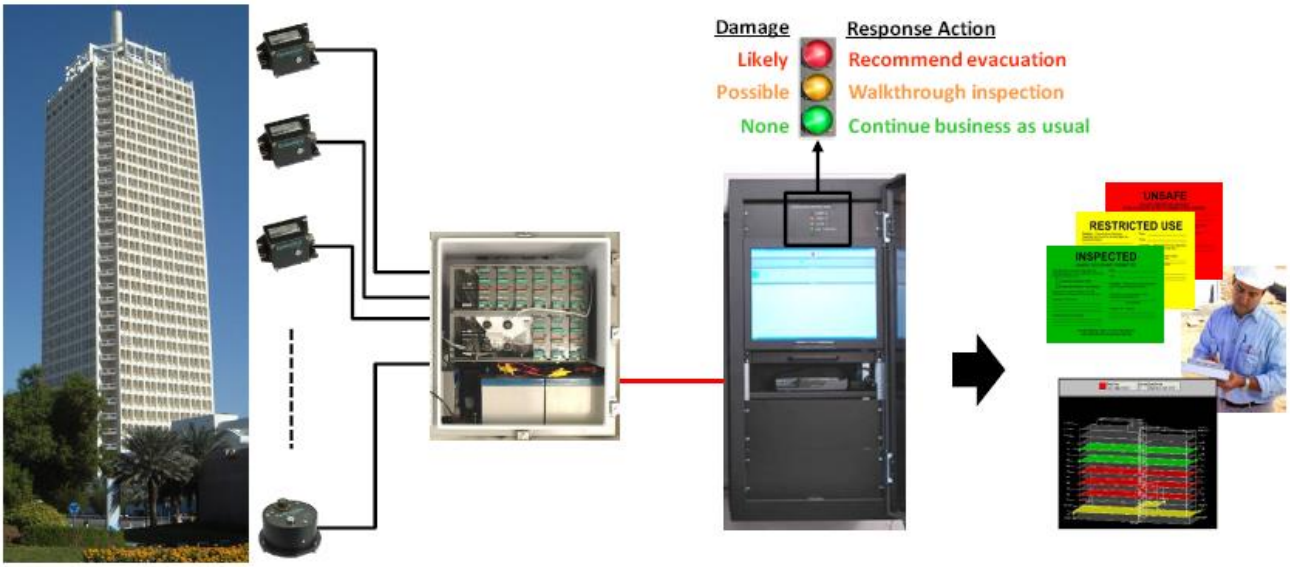

Figure 4. Enhanced Rapid Post-Event Assessment Solution for DWTC, Dubai.

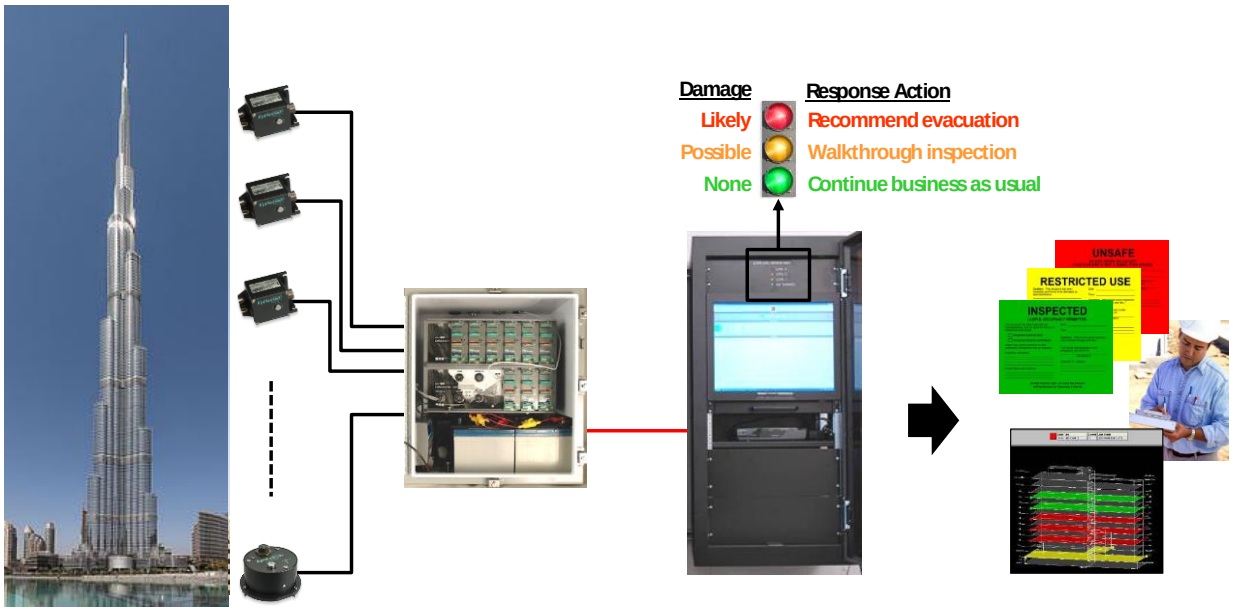

Figure 5. Enhanced Rapid Post-Event Assessment Solution for BK, Dubai

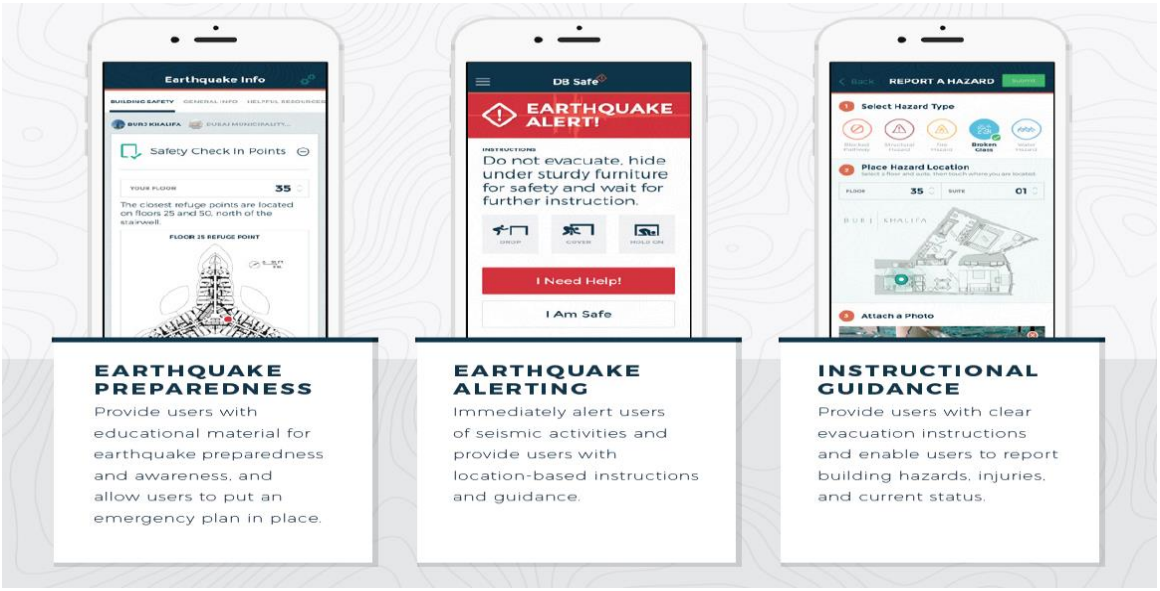

Fig. 6. DB-Safe Application benefits screen shots.

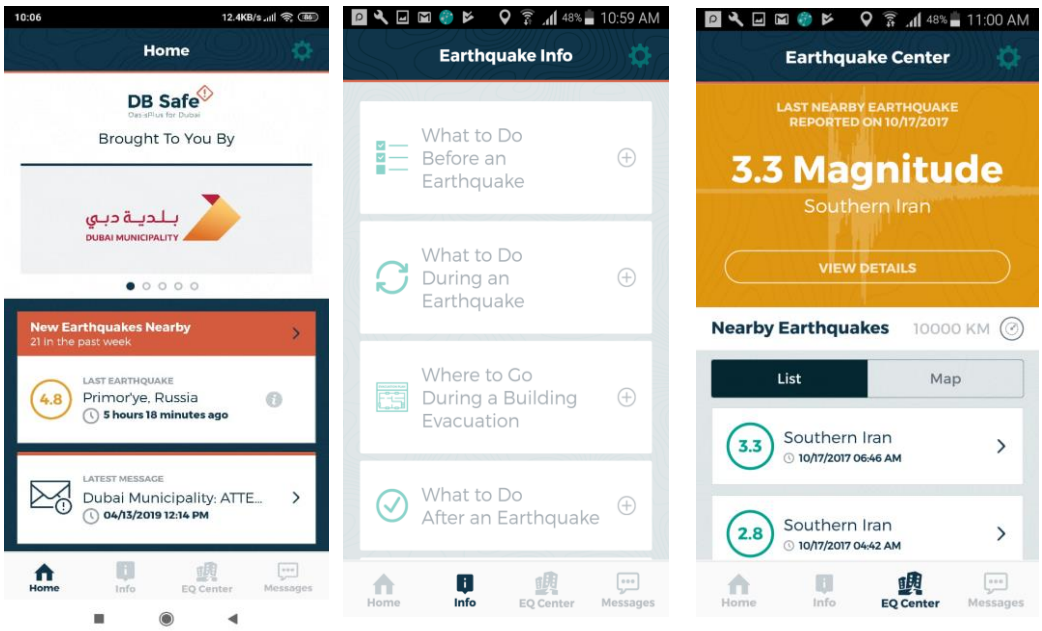

Fig. 7. Some pages of the DB-Safe Application that show the earthquake information and Safety instructions.

HISTORICAL AND RECENT SEISMICITY OF UAE

Historically, there are no reports or indication of any destructive earthquake in UAE. This could be a result of poor catalogue completeness with respect to M>5 earthquakes and their long recurrence time. Recent seismic activity from 1964 up to June 2006 shows few scattered inland earthquakes due to the availability of seismic stations in the region. The most significant inland earthquake is that of March 11, 2002 (M_w ~5) earthquake which occurred in Masafi area and recorded by the worldwide seismic networks **(Fig. 8)**. This moderate size event was felt throughout the northern emirates and was accompanied by smaller (felt) events before and after the March 11 main shock. The majority of seismic activity took place on the southern part of Iran along Zagros belt as a result of the collision between the Arabian Plate and Eurasian plate. This belt presents one of the most seismically active continental regions on the Earth.

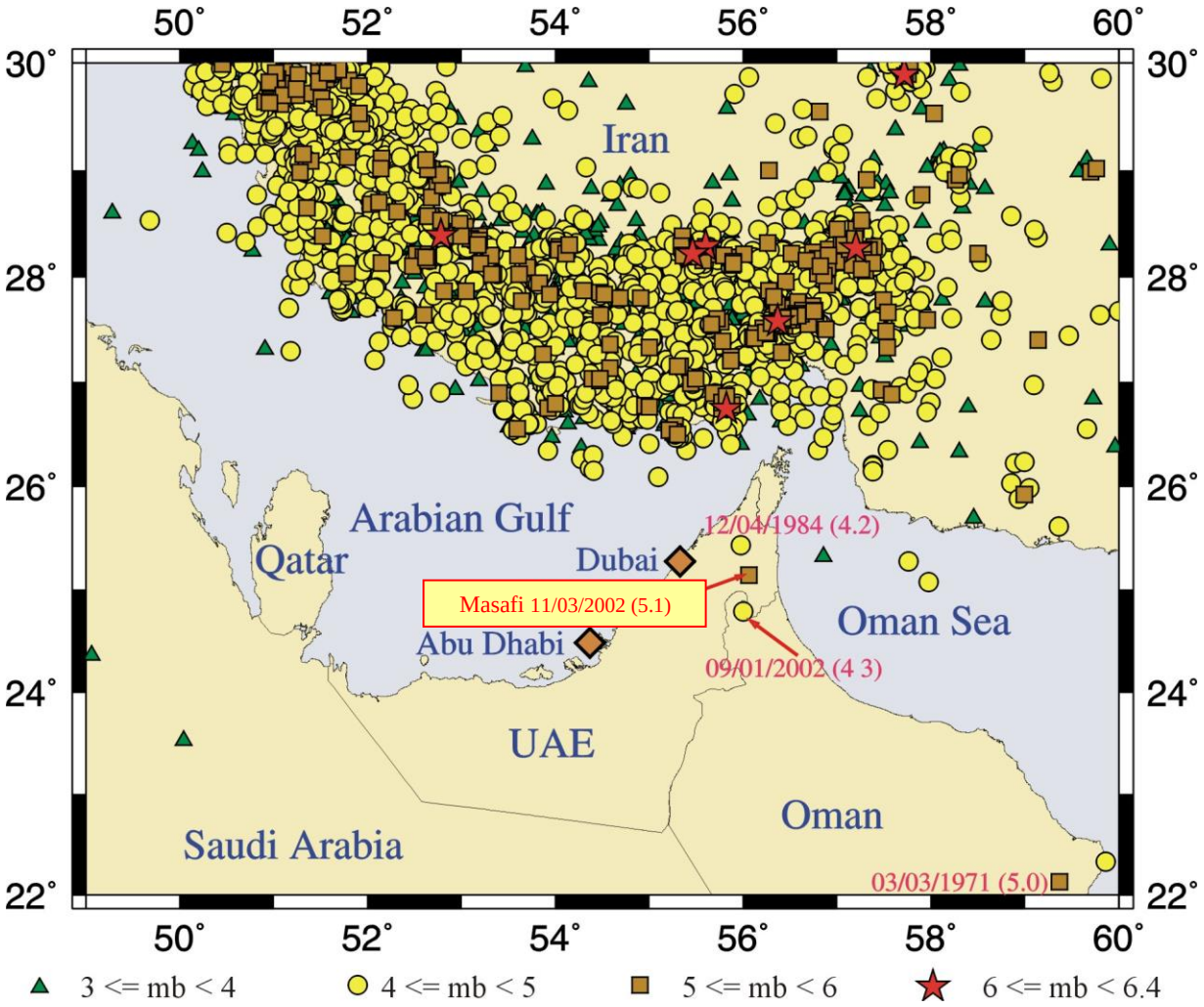

Figure 8. Seismicity of UAE during the period from 1964 to 2006, ISC data.

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LOCAL SEISMIC ACTIVITY

The observed seismic activity from April 2006 to December 2020 indicates light local seismicity on northeastern part of UAE along Masafi-Bani Hamid area, near Wadi Nazawa and northern Huwaylat **(Fig. 9).** Most of the inland seismic activity took place to the east of Masafi and constitute a cluster of activity nearly trending NE. This trend may be continuing beneath the Oman Sea and extends towards Iran. This trend may be an impact of the shear zone separating the two different tectonic processes; a collision along Zagros Belt and a subduction along the Makran Zone.

The seismic activity in Wadi Nazwa may be related to the gas production in Margham field. The focal depth of these earthquakes are shallower (h < 5km), and their magnitude are less than 3. Moreover, the light activity northern Huwaylat may be related to small fault segment (~5km) trends NE similar to the eastern Masafi activity. Few of the inland earthquake activity are felt and best recorded by the DM broadband stations. The most significant of these felt events are that of March 10, September 13, 2007, February 12, 2008, February 20, 2011, April 14, 2011 and October 21, 2012 earthquakes that occurred in the northeastern part of UAE **(Fig. 10).** The estimated average local magnitudes of these events were 4.0, 4.4, 3.7, 3.4, 3.2 and 3.8, respectively. No injuries were reported for all of them but the shaking was strong enough in some of them to frighten many residents in AlFujairah, Masafi, Dibba and Khor Fakkan.

Besides these inland felt events, few offshore felt events were well recorded by the local and regional broadband station of DSN, NCMS and EMC (Oman) centers. These records provide an excellent opportunity to study the tectonic process and present day stress field acting on this area. Regional full waveform inversion of all felt inland earthquakes northeastern UAE show normal faulting mechanisms along nearly NNE-SSW fault planes, in perpendicular direction to the major shortening direction between Arabian plate and Eurasian plate at Zagros Belt. The focal mechanism of a closer event to Iran in the Arabian Gulf indicate reverse fault at deeper focal depth (above 30 km). The focal mechanisms of the offshore events are consistent with the predominant compression stress regime in Oman Sea, except for the event of June 8, 2009 off shore to the east of Musandam which shows normal faulting mechanism. The installation of new broad band stations, defining accurate crustal structure and sharing seismic data between Arabian Gulf countries are highly recommended to reduce the earthquake hazard on the region.

The deployment of seismic networks in Dubai, Abu Dhabi and Oman reveal low to moderate tectonic activity in the northern Oman Mountains that was previously unknown. Continued observation and analysis will reveal the characterization of seismicity and assessment of seismic hazard in the region.

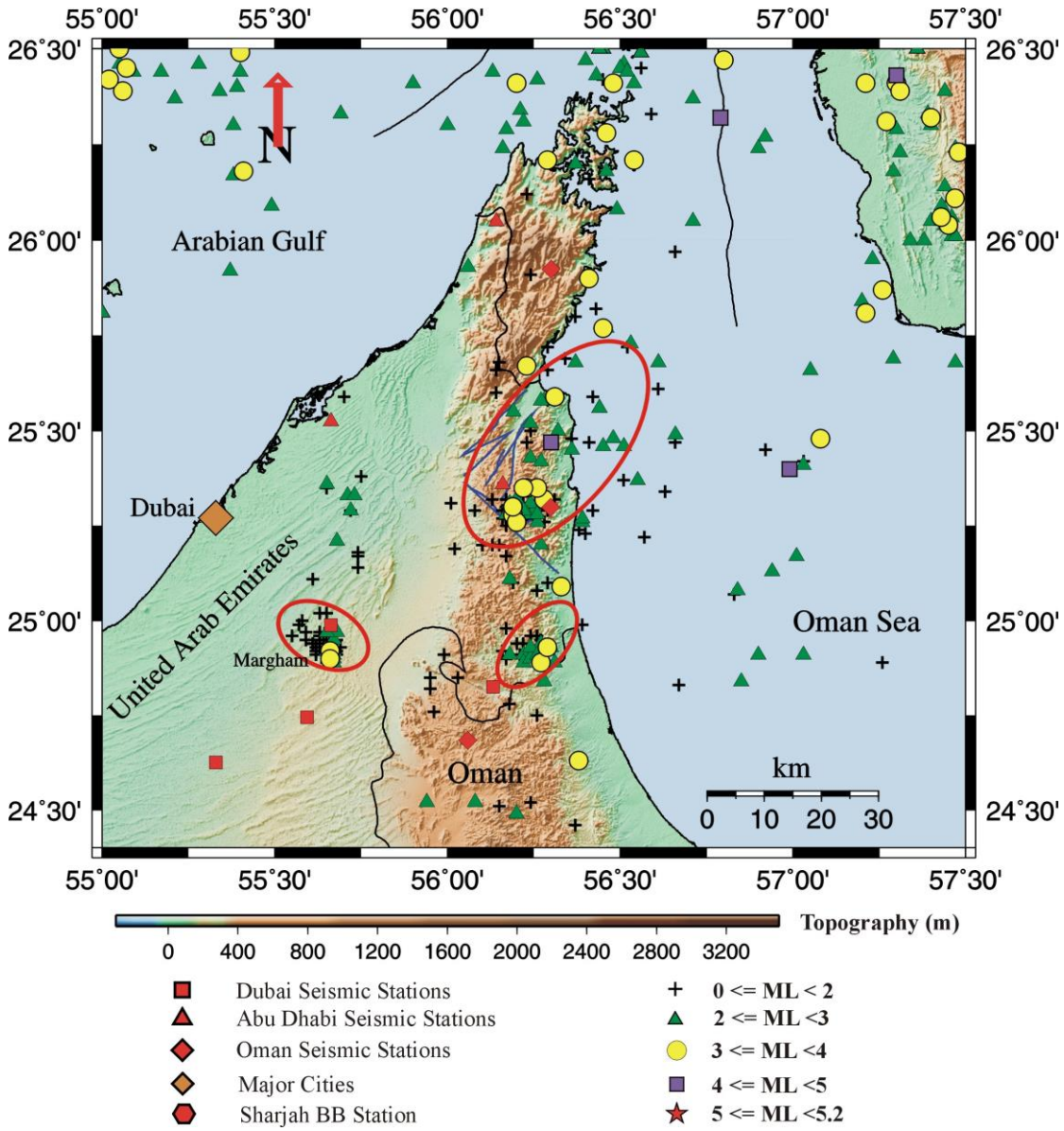

Figure 9. Local seismic activity of UAE from April, 2006 to December 2020. known surface faults crossing Eastern UAE are shown

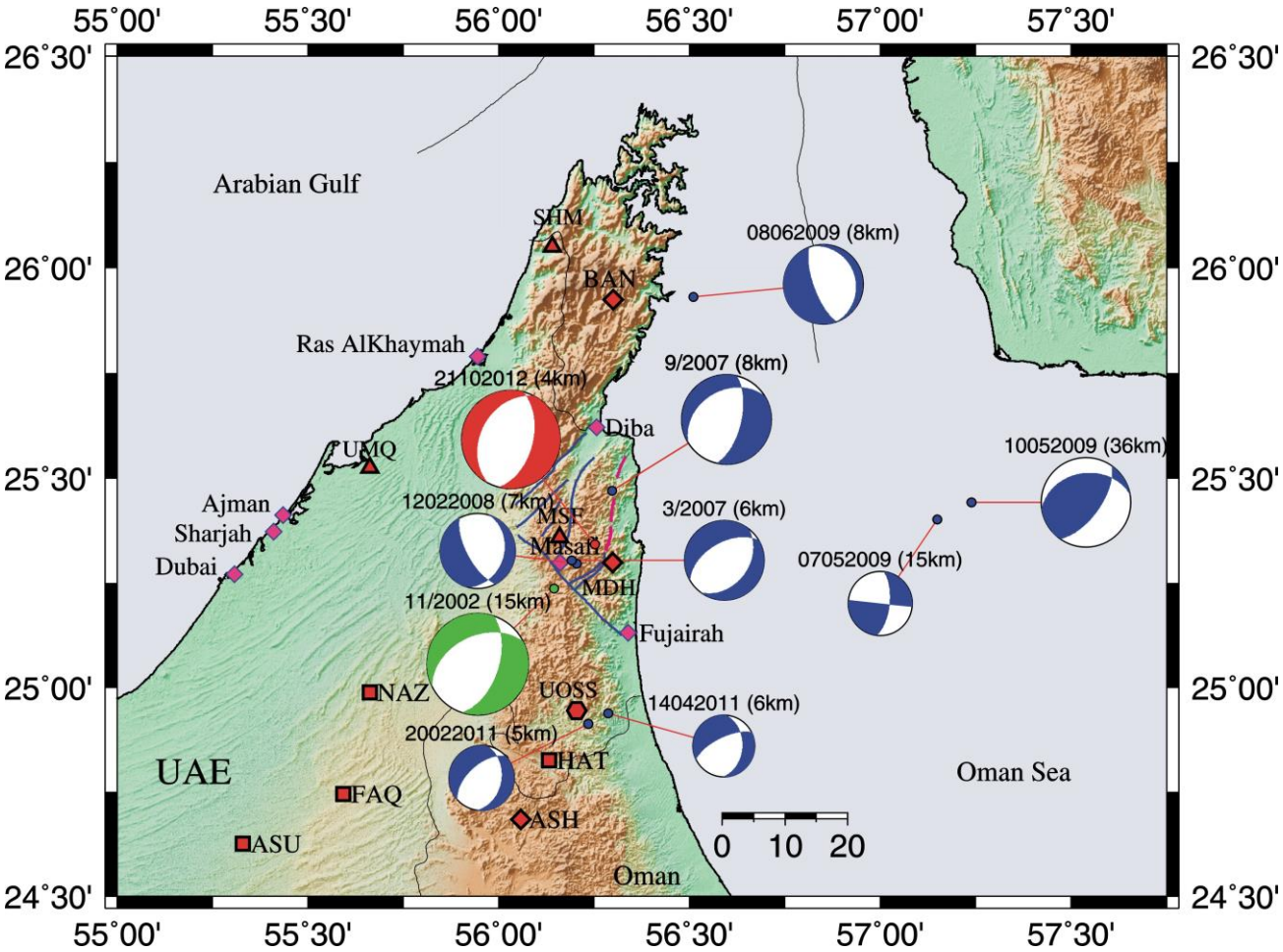

Figure 10. Focal mechanisms of the felt and well recorded events by DSN broadband stations. Each event is entitled by its date and focal depth.

LOCAL SEISMIC ACTIVITY OF 2020

On 2020, DM seismic stations record **911** of local, regional and teleseismic events. Of them, 10 local earthquakes took place inland **(Fig. 11)**. Three of these local events with magnitudes 1.4, 2.1, 1.6 at December 12 and December 30 occurred close to Margham gas field. These three events are not felt by any one on Dubai because they are too small. Two small non felt events occur north and east of Musandam with magnitudes 2.0 and 1.5 at May 31, October 10. The area closer to Dibba fault shows three small non felt events with magnitudes 1.1, 1.3, 2.0

at January 24, May 30 and July 12. Only one small event with magnitude 1.4 on January 7 occur to the east of Masafi. The only local felt event occur on Oman Sea east of Fujairah with magnitude 3.2 on September 4, 2020 (Fig. 12).

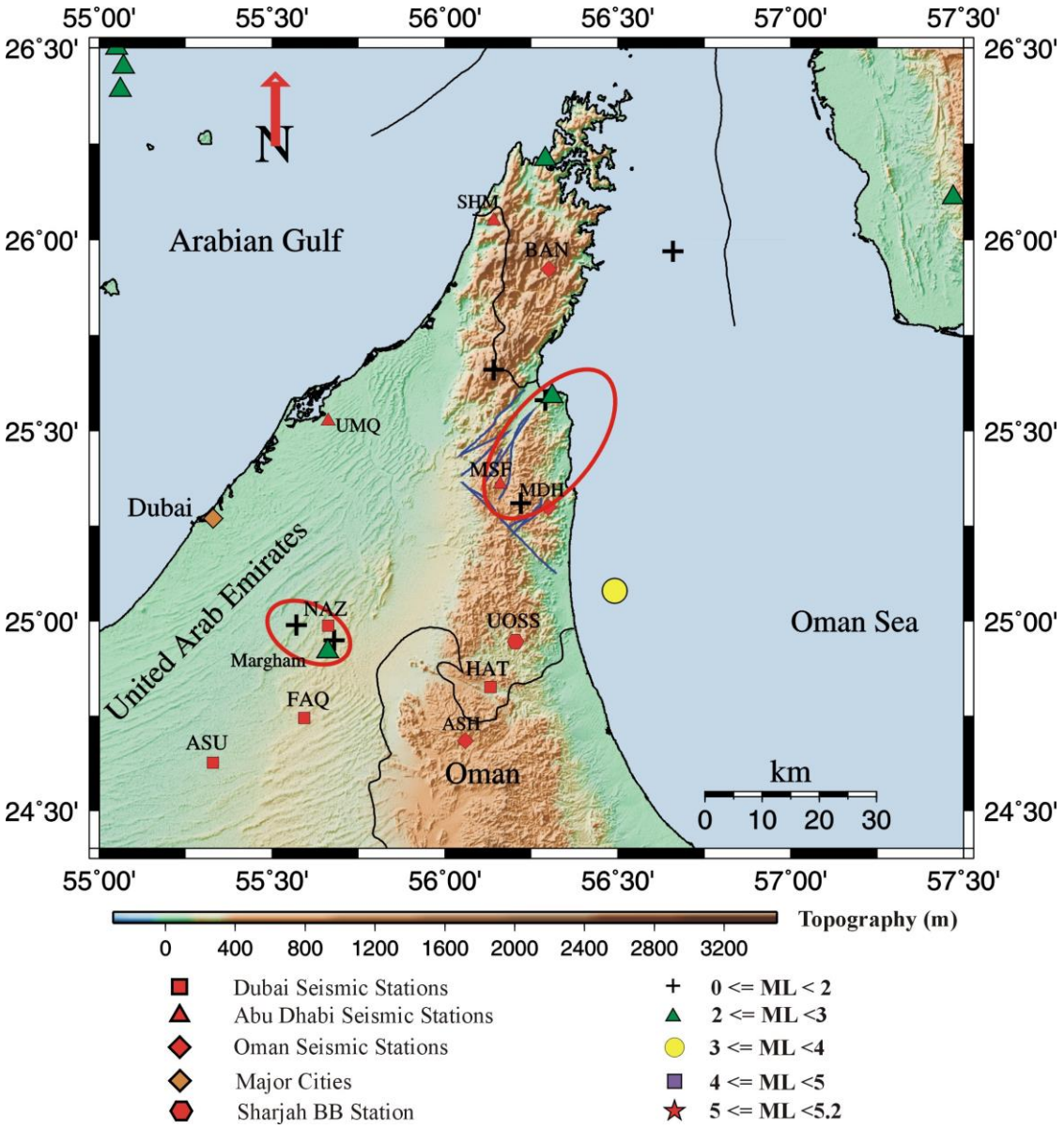

Figure 11. Location of local earthquakes recorded during the period from January to December 2020.

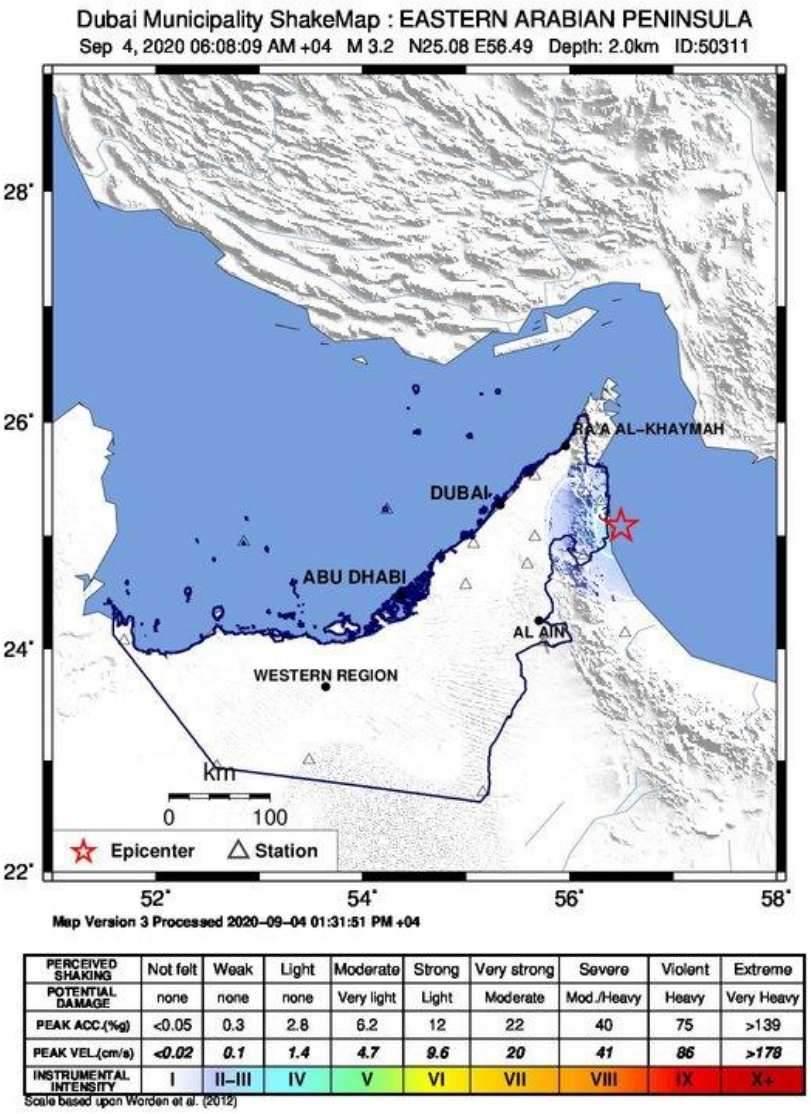

Figure 12. Intensity map of the felt local UAE event of September 4, 2020.

REGIONAL SEISMIC ACTIVITY

The regional seismicity from April 2006 up to December 2020 clearly shows a cluster of the seismic activity along the southern part of Iran. All of these earthquakes occur in the crustal part of the Arabian plate that underlies the Zagros Mountain and Makran region. **Figure 13** shows the epicentral distribution of the regional events which are clustered along the Zagros Fold Belt and the suture boundary between Zagros Fold Belt and Makran subduction zone. The maximum size of the recorded events is less than 6.4 mb while the focal depth is less than 40km.

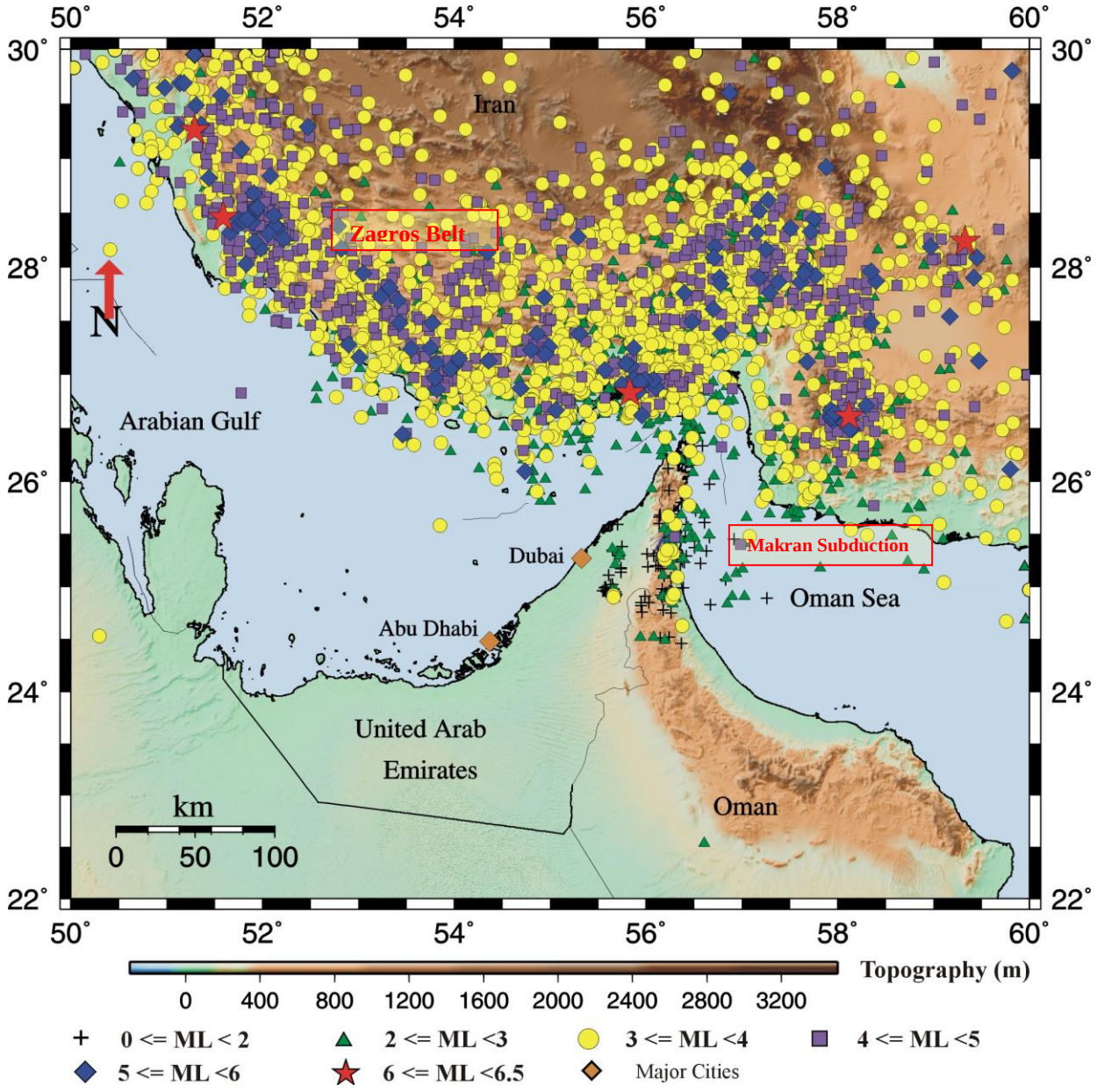

Figure 13. Location of regional earthquakes during the period from April, 2006 to December, 2020.

REGIONAL SEISMIC ACTIVITY OF 2020

The regional seismic activity in 2020 took place on the southern part of Iran northern, eastern and southwest parts of Qeshm Island, along the transition between Zagros collision and Makaran subduction and north of Bushehr. **Figure 14** shows the location of all recorded regional earthquakes by Dubai Seismic Network during 2020.

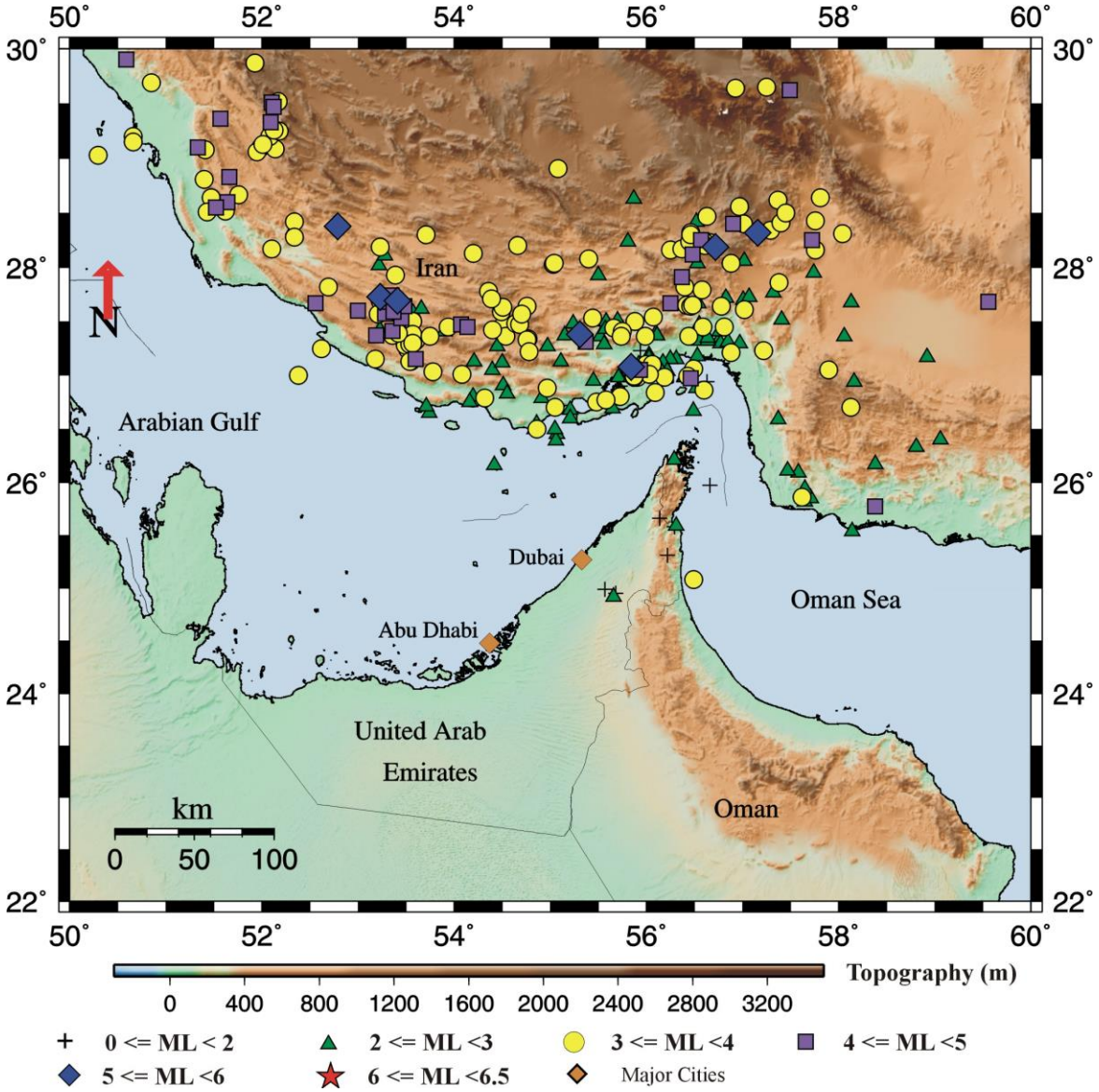

Figure 14. Location of regional earthquakes recorded during the period from January, 1 to December, 31, 2020.

SIGNIFICANT RECOREDED LOCAL EARTQHAUKES DURING 2020

All recorded inland local events in 2020 are smaller (0<=ML<3.5). The only felt event of all local activity during 2020 is that of September 4 (Fig. 12) which occur on Oman Sea east of Fujairah. While the second important one but not felt is that close to Margham gas filed with a local magnitude ~2.1 occurred at December 30 (Fig. 11). Generally, most of local earthquake activity took place closer to Masafi and Dibba area related small fault segments trending NW.

SIGNIFICANT RECOREDED REGIONAL EARTQHAUKES DURING 2020

Most of felt regional earthquakes took place to the south of Iran in the region facing the UAE coastal area, specially the northeastern part of UAE as it becomes closer to Iran area at Hormoz strait. The first event was on January 22 (5.0 ML) at 23:23 (GST) and hit Southern Iran and slightly felt on Ras al Khaimah (Figs. 15, 16). While, the second significant event is that of February 16, (5.2 ML, 16:30, GST) which took place to the north of Qeshm Island. This event was slightly felt on Ras al Khaimah, Sharjah and Dubai (Fig. 17).

The third felt southern Iran event (Fig. 18) is that of March 16, 2020 (5.7 ML, 02:04 GST). While the fourth felt event (Fig 19) is of March 27 (5.3 ML, 10:40 GST). Both of March 2020 previous events was felt on all northern UAE Emirates Ras al Khaimah, Sharjah and Dubai. The fifth significant event is that of May 24 (5.0 ML, 13:11GST) that located closer to Bushehr area. The six and seven important regional events are that of June 9 (5.3, 5.2 ML, 20:08, 21:18 GST, respectively) which located to the south of Bushehr and felt on Dubai emirate (Figs. 20, 21). The eight significant southern Iran event (Fig. 16) is that of August 31 (5.1 ML, 12:31 GST).

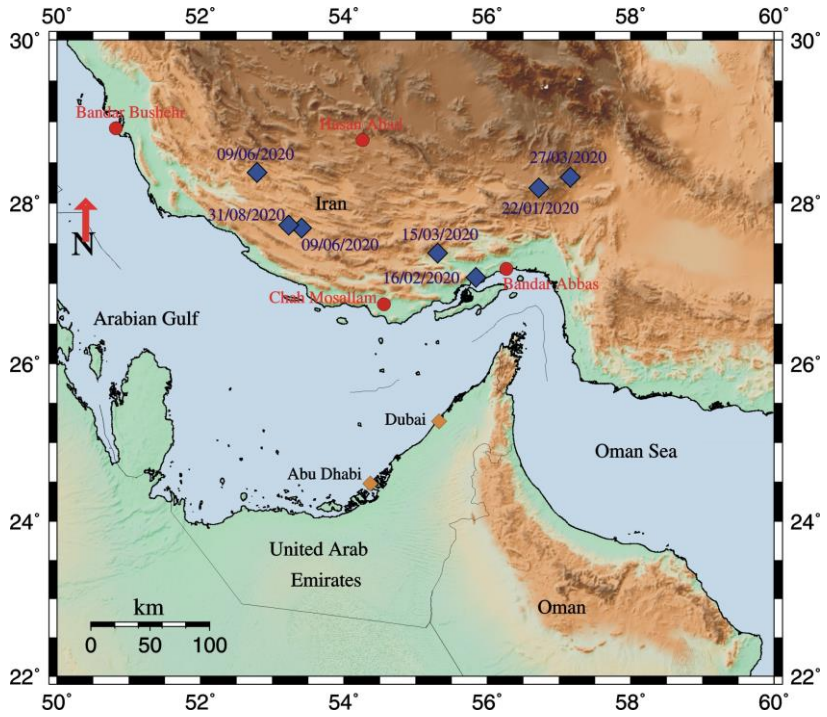

Figure 15. Significant recorded regional earthquakes during 2020 by DSN.

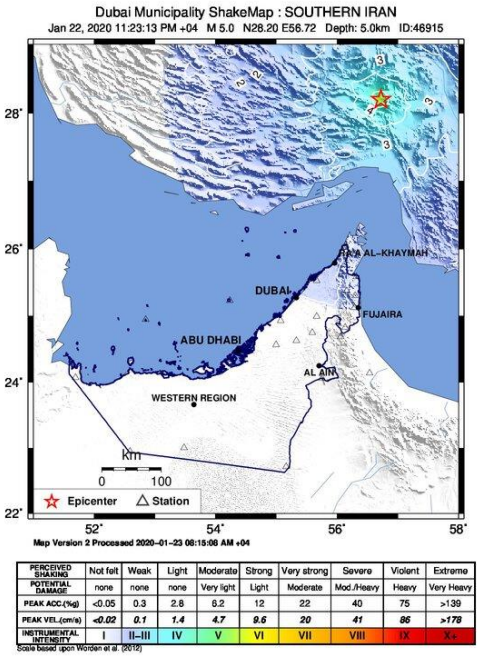

Figure 16. Shakemap of January 22, 2020 southern Iran earthquake.

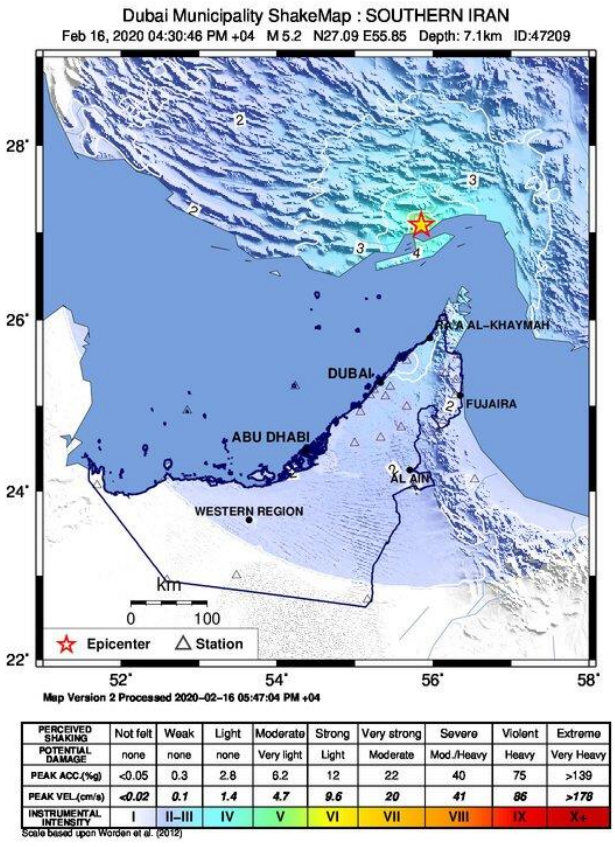

Figure 17. Shakemap of February 16, 2020 southern Iran earthquake.

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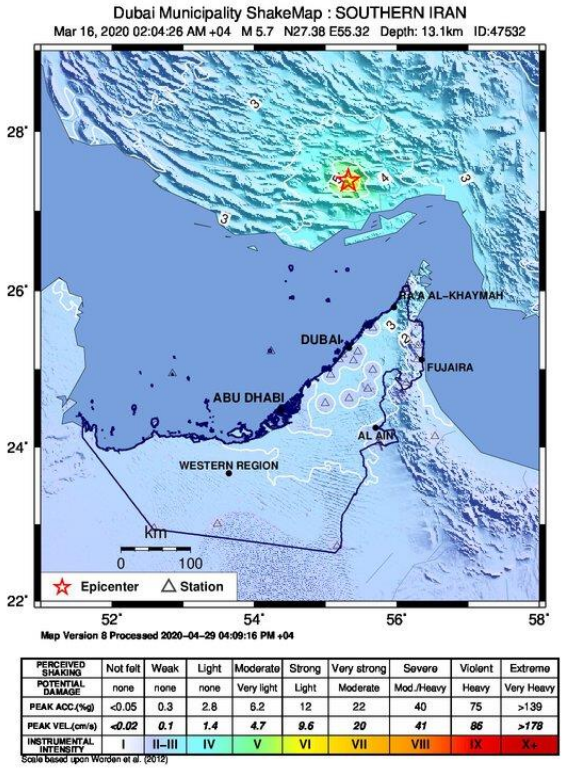

Figure 18. Shakemap of March 16, 2020 (GST), southern Iran earthquake.

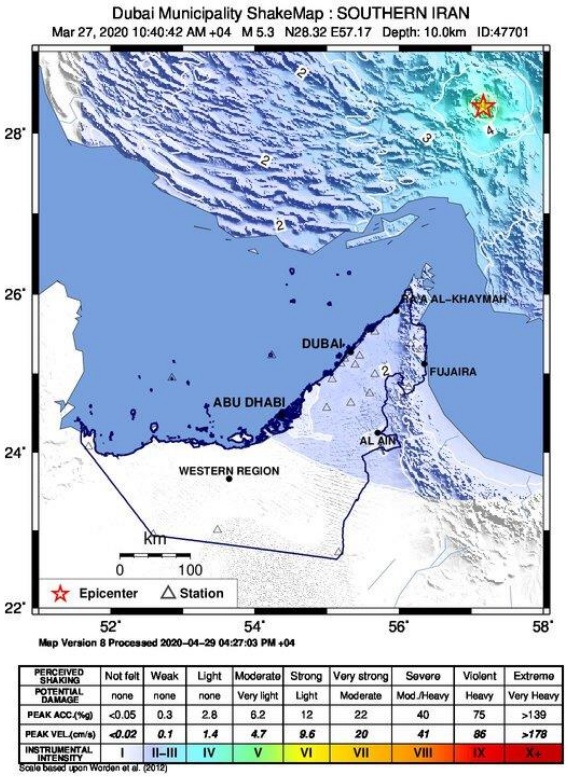

Figure 19. Shakemap of March 27, 2020, southern Iran earthquake.

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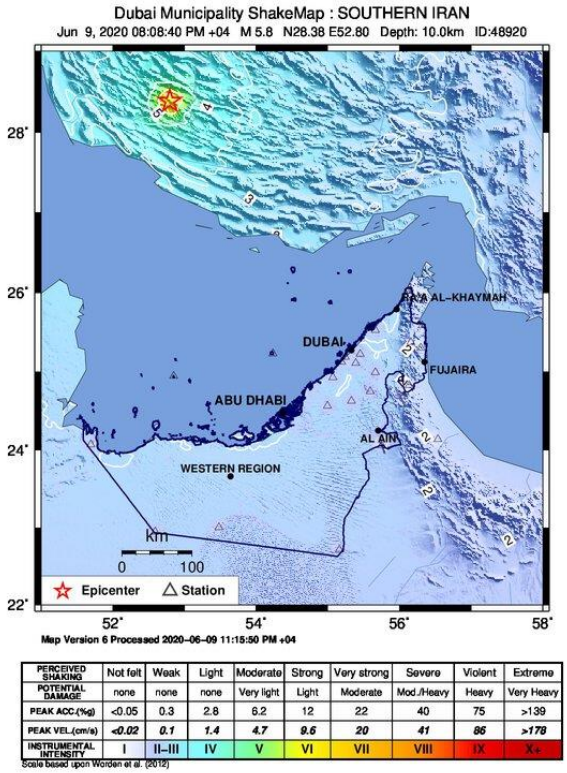

Figure 20. Shakemap of June 9 (5.3 ML, 20:08 GST), southern Iran earthquake.

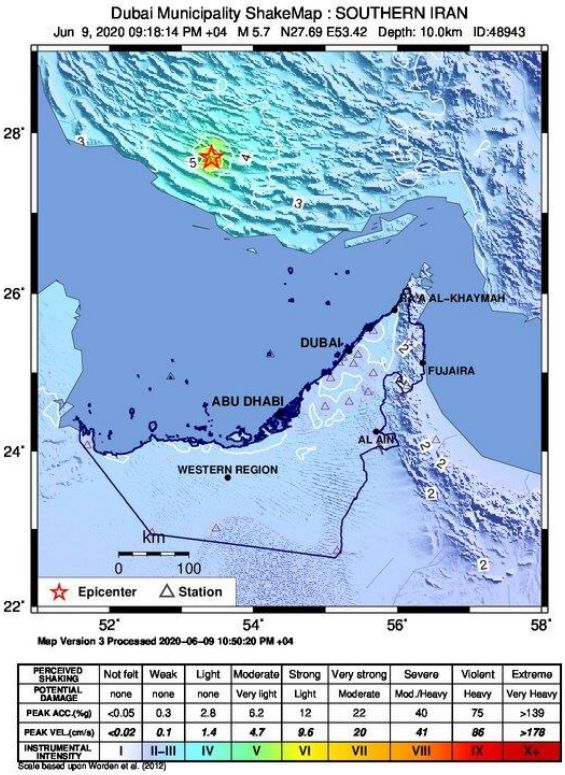

Figure 21. Shakemap of June 9 (5.2 ML, 21:08 GST), southern Iran earthquake.

بيانات مفتوحةOPEN DATA /

RECORDED WORLDWIDE SEISMIC ACTIVITY

DM seismic network recorded many worldwide earthquakes from April, 2006 to December 2020 **(Fig. 22).** Most of these activities are clustered along the subduction belt that called Pacific Ring of Fire. It is an area where large numbers of earthquakes and volcanic eruptions occur in the basin of the Pacific Ocean. In a 40,000 km (25,000 mi) horseshoe shape, it is associated with a nearly continuous series of oceanic trenches, volcanic arcs, and volcanic belts and/or plate movements. About 90% of the world's earthquakes and 80% of the world's largest earthquakes occur along this Ring of Fire. The next most seismic region (5–6% of earthquakes and 17% of the world's largest earthquakes) is the Alpide belt, which extends from Java to Sumatra through the Himalayas, the Mediterranean, and out into the Atlantic. The Mid-Atlantic Ridge is the third most prominent earthquake belt.

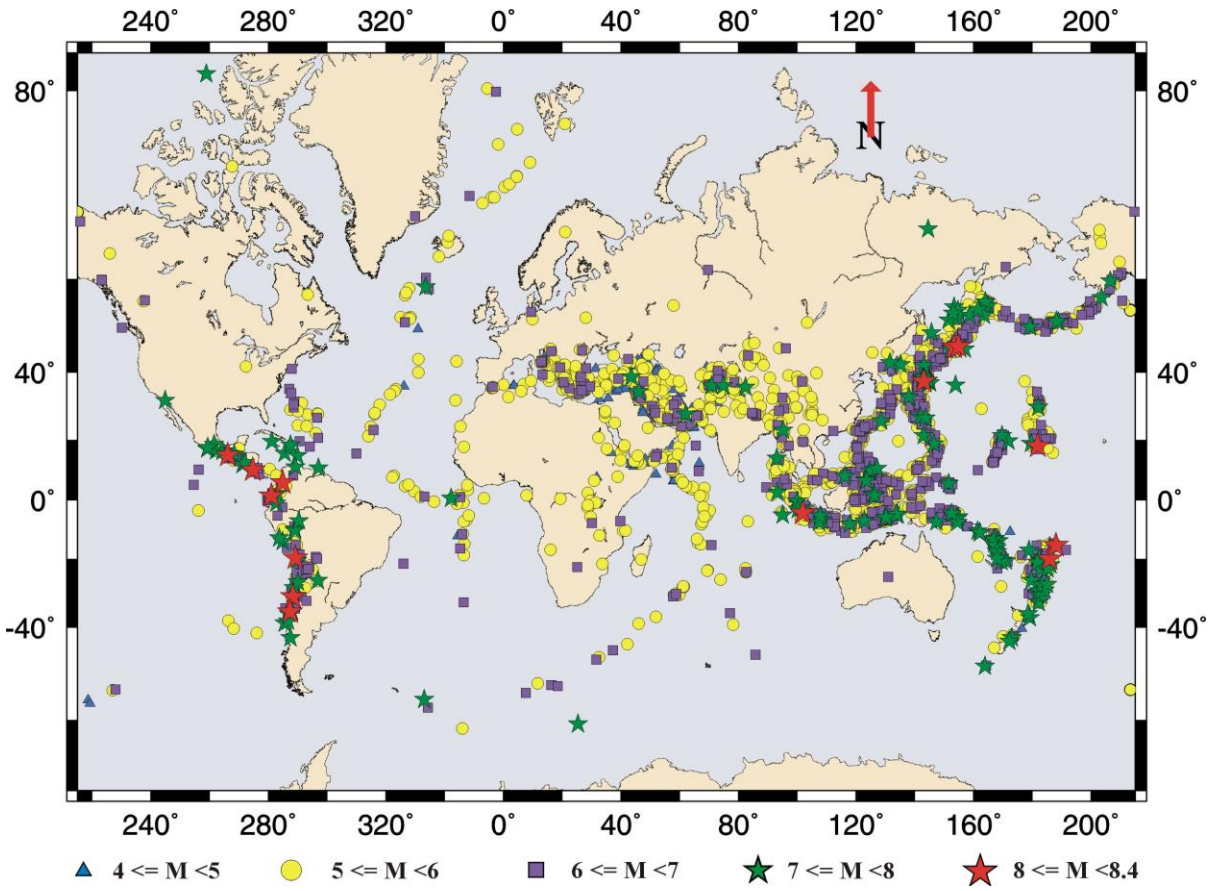

Figure 22. Location of worldwide earthquakes (M_L >= 4.0) recorded by DSN during the period from April, 2006 to December 2020.

RECORDED WORLDWIDE SEISMIC ACTIVITY DURING 2020

Most of the recorded events took place along the Ring of Fire in the Pacific Ocean. Much of largest events took place to the east of Honshu Island (Japan), Eastern Russia and Eastern Australia and western South American. Part of the activity took place along the Alpide bets that extends from Iran to Turkey and the Mediterranean region **(Fig. 23).**

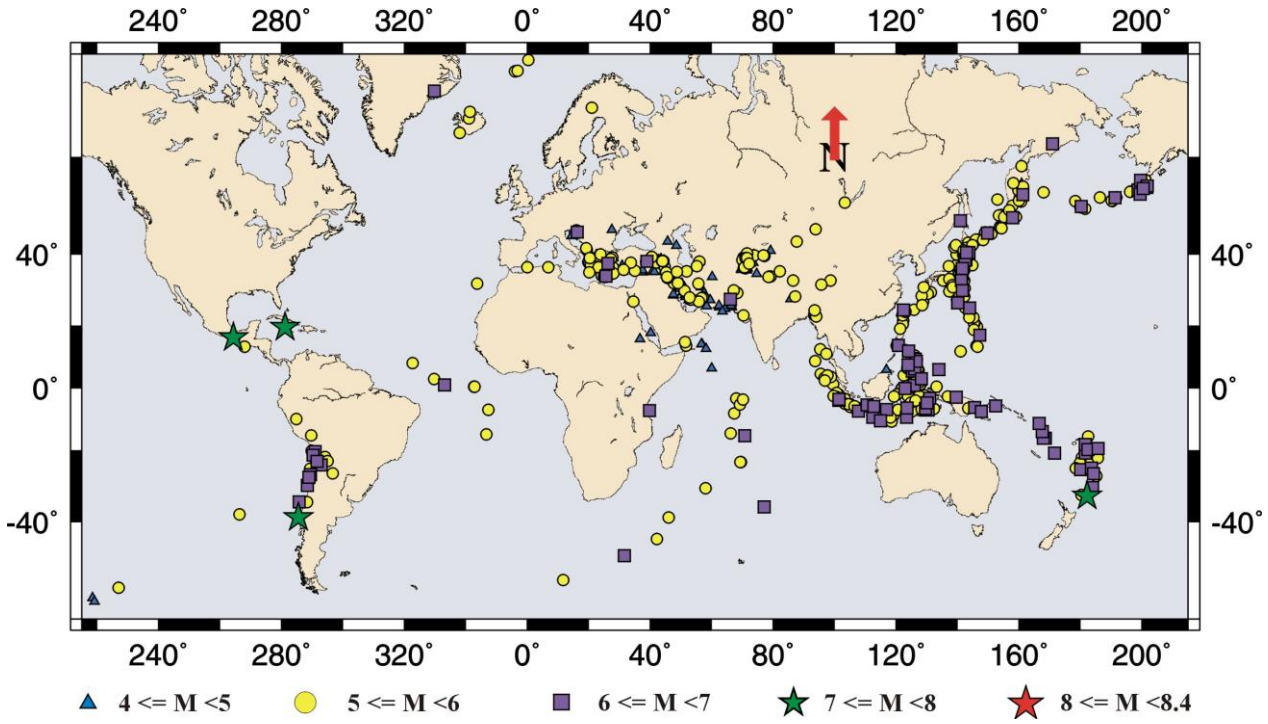

Figure 23. Location of worldwide earthquakes (M_L >= 4.0) recorded by DSN during the period from January, 1 to December, 31, 2020.

SIGNIFICANT WORLEDWIDE EARTQHAUKES RECOREDED DURING 2020

The most significance events of 2020 which caused some death are that of Izmir, Turkey (October 30, M=7.0), Elâzığ, Turkey (January 24, M=6.7), Oaxaca, Mexico (June 23, M=7.4), Van, Turkey (February 23, M=5.8). The number of peoples death related to these events are shown on Table 3 while their comparative size to all events of 2020 are shown on Table 4 *(Ref: https://en.wikipedia.org/wiki/List_of_earthquakes_in_2020)*.

Table 3: The 2020 damaging earthquakes with at least 10 dead.

Rank	Death toll	Magnitude	Location	MMI	Depth (km)	Date	Event
1	119	7.0	Turkey, İzmir Greece, North Aegean offshore	VIII (*Severe*)	21.0	October 30	**2020 Aegean Sea earthquake**
2	41	6.7	Turkey, Elazığ	IX (*Violent*)	10.0	January 24	**2020 Elazığ earthquake**
3	10	7.4	Mexico, Oaxaca	VIII (*Severe*)	20.0	June 23	**2020 Oaxaca earthquake**
3	10	5.8	Turkey, Van Iran, West Azerbaijan	VII (*Very strong*)	10.0	February 23	**2020 Iran–Turkey earthquakes**

Listed are earthquakes with at least 10 dead.

Table 4: The 2020 larger earthquakes with at least 7.0 magnitude.

Rank	Magnitude	Death toll	Location	MMI	Depth (km)	Date	Event
1	7.8	0	United States, Alaska offshore	VII (*Very strong*)	28.0	July 22	**July 2020 Alaska Peninsula earthquake**
2	7.7	0	Jamaica, Hanover offshore	VI (*Strong*)	14.9	January 28	**2020 Caribbean earthquake**
3	7.6	0	United States, Alaska offshore	VII (*Very strong*)	35.4	October 19	**October 2020 Alaska Peninsula earthquake**
4	7.5	0	Russia, Kuril Islands offshore	V (*Moderate*)	56.7	March 25	**2020 Kuril Islands earthquake**
5	7.4	10	Mexico, Oaxaca	VIII (*Severe*)	20.0	June 23	**2020 Oaxaca earthquake**
5	7.4	0	New Zealand, Kermadec Islands offshore	VII (*Very strong*)	10.0	June 18	-
7	7.0	119	Turkey, İzmir Greece, North Aegean offshore	VIII (*Severe*)	21.0	October 30	**2020 Aegean Sea earthquake**
7	7.0	1	Papua New Guinea, Oro offshore	VII (*Very strong*)	73.0	July 17	-
7	7.0	0	Russia, Kuril Islands offshore	VI (*Strong*)	144.0	February 13	-

Listed are earthquakes with at least 7.0 magnitude.

RECORDED EVENT PARAMETERS

The parameters of the recorded local and regional earthquakes are listed in Tables 5, 6.

CONCLUSIONS

During 2020, Dubai Seismic Network recorded 911 earthquakes, only 10 events among of them were located in the northeastern part of UAE. While, most of the regional seismic activity took place in the southern part of Iran along Zagros fold belt. Most of the recorded worldwide events are located along the plate boundaries. The rate of local activity in 2020 was slightly lower compared to the previous 2017, 2018 and 2019. From the recorded 10 local events 3 located on Margham gas field area, 4 located on the area of Dibba- Masafi, 2 on Musandam (Fig. 11). The only local felt event occur on Oman Sea east of Fujairah with magnitude 3.2 on September 4, 2020 (Fig. 12).

Few regional moderate size southern Iran earthquakes took place during 2020 and felt on the northern Emirates of UAE. Most of these felt events were located to the north of Qeshm Island or to the south of Bushehr area (Fig. 15).

The source mechanisms of few significant felt local earthquakes (i.e. March, 10, September 13, 2007, February 12, 2008, February 20, 2011, April 14, 2011 and October 21, 2012) show normal faulting mechanism trending NE to NNE in consistence with Bani Hamid fault and another fault located north of Huwayalt region. The future cooperation and data exchange with the neighboring network will led to improve the accuracy earthquakes location in the Gulf area. Installation of more seismic station in the north part of UAE will increase the detectabilty of recording the microseismicity and define the local active faults.

RECOMMENDATIONS

All tall towers in Dubai with height over 120m have to be equipped with smart structural health monitoring system to the support all emergency cases in case of any felt earthquake or a strong wind. Also, it is recommended to install two more VBB station at Jebal Ali to increase the aperture of DSN. Moreover, the update and evaluation of DB-Safe smart application is very useful to monitor the Dubai resident's awareness about earthquake risk and to have a powerful tool in case of any earthquake emergency case.

Table 5. Parameters of the recorded local earthquakes by DM Seismic Network during 2020.

Date D. Mo. Yr.	Origin Time Hr. Mn. Sec	Locations Lat.°	Long.°	Depth (km)	ML
07 01 2020	13 41 08.0	25.31	56.22	09.5	1.4
24 01 2020	09 20 34.6	25.58	56.29	13.0	1.1
30 05 2020	17 00 33.2	25.66	56.14	07.4	1.3
31 05 2020	05 59 47.3	26.21	56.29	05.0	2.0
12 07 2020	00 51 54.9	25.59	56.31	17.0	2.0
04 09 2020	02 08 09.9	25.08	56.49	02.0	3.2
10 10 2020	20 10 02.5	25.97	56.66	10.0	1.5
12 12 2020	00 59 57.2	24.95	55.68	05.0	1.4
30 12 2020	07 02 39.6	24.92	55.66	05.0	2.1
30 12 2020	15 20 04.5	24.99	55.57	10.5	1.6

Table 6. Parameters of the recorded regional earthquakes (N°22:30, E°50:60) by DM Seismic Network during 2020.

Date D. Mo. Yr.	Origin Time Hr. Mn. Sec.	Locations Lat.°	Long.°	Depth (km)	ML
01 01 2020	00 13 46.7	27.45	56.81	10.0	3.5
01 01 2020	00 46 10.2	27.30	56.77	10.0	2.4
01 01 2020	01 05 57.1	27.41	56.76	10.0	2.5
01 01 2020	01 09 54.9	27.47	56.55	10.0	2.6
01 01 2020	06 50 15.8	27.35	56.64	10.0	2.9
01 01 2020	10 57 25.1	27.31	56.85	10.0	2.9
02 01 2020	21 16 21.9	27.32	56.75	10.0	2.3
02 01 2020	23 13 33.2	27.30	56.97	10.0	2.8
03 01 2020	10 26 06.8	27.10	56.00	10.0	3.1
04 01 2020	17 16 34.2	28.62	57.37	10.0	3.2
08 01 2020	02 20 02.9	29.10	51.33	10.0	4.2
08 01 2020	03 19 18.4	28.81	51.40	10.0	3.9
09 01 2020	02 08 26.6	28.43	57.76	15.0	3.0
11 01 2020	09 50 19.4	25.86	57.62	05.0	3.1
11 01 2020	12 20 29.2	25.85	57.71	05.0	2.2
12 01 2020	03 01 51.1	28.67	51.76	05.0	3.9
15 01 2020	14 56 18.1	26.70	55.05	06.4	3.4
18 01 2020	21 55 05.4	25.94	57.65	15.0	2.5
20 01 2020	14 49 35.7	27.91	56.37	10.0	4.0
20 01 2020	17 58 03.2	27.32	56.64	10.0	2.8
22 01 2020	19 23 13.5	28.19	56.72	05.0	5.1
22 01 2020	23 30 32.5	28.23	56.66	10.0	3.0
24 01 2020	18 31 25.6	26.75	55.48	15.0	3.6
25 01 2020	14 07 15.5	28.42	56.52	10.0	2.7
27 01 2020	13 28 29.0	29.47	52.12	15.0	4.9
28 01 2020	15 24 35.2	29.51	52.10	15.0	4.8
28 01 2020	17 15 31.8	29.20	52.08	15.0	3.1
29 01 2020	22 18 00.3	28.06	57.02	15.0	2.6
03 02 2020	20 32 41.2	29.26	52.13	15.0	3.5
05 02 2020	00 31 21.9	27.17	58.92	10.0	2.4
12 02 2020	19 41 16.2	27.01	55.90	15.0	3.0
12 02 2020	19 46 55.3	27.03	55.90	15.0	2.0
12 02 2020	23 39 10.9	26.98	55.91	15.0	3.2
16 02 2020	12 21 52.9	27.07	55.87	06.7	3.6
16 02 2020	12 24 30.3	27.01	56.03	10.0	3.6
16 02 2020	12 24 53.7	27.05	55.93	10.0	4.1
16 02 2020	12 29 19.2	27.01	56.09	10.0	2.1
16 02 2020	12 30 46.6	27.08	55.84	07.0	5.3
16 02 2020	12 52 55.4	27.05	56.02	03.8	1.9
16 02 2020	13 07 01.3	27.04	55.98	07.1	1.8

Table 6. Continues

Date D. Mo. Yr.	Origin Time Hr. Mn. Sec.	Locations Lat.°	Long.°	Depth (km)	ML
16 02 2020	14 10 31.7	27.06	55.83	02.6	3.3
16 02 2020	15 00 38.0	27.08	56.09	05.7	2.0
16 02 2020	17 31 54.3	27.04	56.05	05.0	2.1
16 02 2020	19 59 51.0	27.05	56.07	05.5	2.3
16 02 2020	20 27 11.9	26.98	55.71	14.8	2.1
16 02 2020	23 59 14.7	27.18	56.03	05.0	2.0
17 02 2020	00 29 18.9	27.33	54.76	10.0	3.6
17 02 2020	13 11 58.4	26.98	55.84	15.0	2.7
17 02 2020	16 03 57.9	27.08	56.13	06.2	2.5
17 02 2020	19 36 03.4	27.13	55.11	15.0	2.8
20 02 2020	14 12 55.9	27.86	57.38	10.0	3.0
20 02 2020	17 54 45.4	26.11	57.47	10.0	2.2
20 02 2020	21 38 26.2	27.64	54.76	10.0	3.2
21 02 2020	09 59 02.6	26.60	55.21	10.0	2.7
21 02 2020	21 04 12.3	27.34	54.77	10.0	3.0
22 02 2020	08 12 22.3	27.37	56.11	10.0	2.6
23 02 2020	01 12 24.2	28.04	56.88	10.0	3.8
23 02 2020	17 17 31.0	28.56	56.97	10.0	3.2
24 02 2020	07 45 18.3	27.47	54.68	10.0	3.3
24 02 2020	07 55 25.4	27.57	54.70	10.0	3.4
25 02 2020	11 42 06.7	26.99	55.87	10.0	3.7
26 02 2020	13 44 27.7	26.09	57.58	15.0	2.0
26 02 2020	20 31 08.4	27.10	56.06	15.0	3.4
26 02 2020	22 11 22.0	28.64	51.47	15.0	3.4
28 02 2020	20 45 57.1	27.82	52.69	10.0	3.2
29 02 2020	19 25 59.9	27.15	56.25	10.0	2.3
02 03 2020	00 07 19.7	27.12	56.17	02.5	2.4
02 03 2020	14 31 13.5	29.10	51.99	15.0	3.1
03 03 2020	11 31 27.2	27.22	54.78	15.0	3.8
04 03 2020	15 36 16.9	26.77	55.58	10.0	3.7
06 03 2020	16 04 20.1	29.25	52.18	15.0	3.5
06 03 2020	18 12 27.0	26.69	55.65	15.0	2.7
11 03 2020	07 55 37.8	27.04	55.84	15.0	2.7
11 03 2020	10 24 09.6	29.33	52.09	15.0	4.0
15 03 2020	03 39 47.0	27.25	52.62	15.0	3.0
15 03 2020	22 04 26.3	27.38	55.31	13.1	5.0
19 03 2020	13 10 27.1	26.33	58.81	20.4	2.7
20 03 2020	09 16 14.2	28.42	52.34	10.0	3.0
25 03 2020	06 30 22.6	28.08	55.40	15.0	3.3
26 03 2020	02 12 00.8	27.72	56.83	15.0	2.0
27 03 2020	06 40 42.7	28.32	57.16	10.0	5.0
27 03 2020	07 22 03.0	29.69	50.85	15.0	3.4
27 03 2020	09 22 41.8	27.45	53.94	15.0	3.0

Table 6. Continues

Date D. Mo. Yr.	Origin Time Hr. Mn. Sec.	Locations Lat.°	Long.°	Depth (km)	ML
27 03 2020	15 48 57.0	29.08	51.41	15.0	3.6
29 03 2020	23 06 46.8	26.90	55.73	10.0	1.8
31 03 2020	01 56 29.4	27.48	55.24	10.0	2.4
31 03 2020	11 44 56.2	27.43	55.67	10.0	2.7
02 04 2020	13 49 08.7	26.83	54.55	10.0	2.5
03 04 2020	03 44 05.7	28.13	54.20	10.0	3.0
03 04 2020	16 06 45.0	26.70	58.13	10.0	3.6
04 04 2020	01 07 03.1	29.52	52.17	10.0	3.1
07 04 2020	17 26 37.6	28.03	55.03	10.0	3.1
08 04 2020	22 43 06.9	27.93	55.50	10.0	2.6
10 04 2020	09 25 13.4	27.37	55.15	15.0	2.5
13 04 2020	08 37 38.5	27.04	56.22	10.0	2.5
15 04 2020	08 10 25.4	28.25	56.57	15.0	4.0
20 04 2020	09 48 00.9	26.16	54.42	10.0	2.6
21 04 2020	13 29 58.6	27.29	55.56	10.0	2.6
22 04 2020	01 07 00.1	26.67	56.49	10.0	2.4
24 04 2020	04 09 23.0	27.32	56.55	01.0	2.1
26 04 2020	16 12 55.6	27.78	54.36	10.0	3.6
28 04 2020	04 49 21.1	29.20	50.66	10.0	3.8
30 04 2020	07 54 47.5	27.65	56.39	10.0	2.7
01 05 2020	18 41 48.0	27.42	53.23	10.0	2.4
01 05 2020	20 28 10.1	28.40	56.90	10.0	4.5
01 05 2020	21 29 35.6	28.04	56.53	10.0	2.9
12 05 2020	13 50 56.2	27.62	53.66	10.0	2.9
15 05 2020	01 26 57.5	27.41	53.90	10.0	2.9
15 05 2020	10 42 55.1	26.91	54.51	10.0	2.5
16 05 2020	03 10 40.5	29.09	52.14	15.0	3.1
18 05 2020	18 15 02.5	28.30	56.46	15.0	3.5
19 05 2020	04 03 27.4	27.12	54.50	10.0	2.9
19 05 2020	04 32 01.1	27.53	55.44	10.0	3.5
19 05 2020	06 43 35.5	26.55	54.86	10.0	2.8
19 05 2020	07 01 07.2	26.50	54.86	10.0	3.1
20 05 2020	23 19 12.1	26.50	54.84	10.0	2.1
21 05 2020	19 07 54.4	27.73	57.07	10.0	2.6
22 05 2020	00 30 47.2	27.79	56.58	10.0	3.0
22 05 2020	10 29 43.2	27.67	56.54	10.0	2.5
22 05 2020	14 41 54.9	27.15	56.31	10.0	2.0
26 05 2020	04 47 38.9	28.11	53.28	10.0	2.8
29 05 2020	02 23 11.5	27.23	57.22	10.0	3.0
29 05 2020	07 13 25.3	28.16	57.76	10.0	3.0
29 05 2020	13 30 23.2	27.36	53.75	10.0	3.5
30 05 2020	22 55 36.8	27.50	53.57	10.0	3.2
31 05 2020	23 59 03.3	27.74	53.35	10.0	4.4

Table 6. Continues

Date D. Mo. Yr.	Origin Time Hr. Mn. Sec.	Locations Lat.°	Long.°	Depth (km)	ML
01 06 2020	21 51 08.5	27.64	56.78	10.0	3.6
02 06 2020	14 57 28.1	28.40	57.01	10.0	3.4
04 06 2020	09 34 09.6	29.87	51.93	15.0	3.4
07 06 2020	21 53 05.0	27.18	56.53	10.0	2.3
09 06 2020	16 08 40.9	28.38	52.79	10.0	5.3
09 06 2020	17 18 14.5	27.69	53.41	10.0	5.2
09 06 2020	17 43 22.2	27.39	53.42	10.0	3.6
09 06 2020	19 44 58.2	27.41	53.36	10.0	4.1
09 06 2020	22 27 01.6	27.64	53.29	10.0	3.7
10 06 2020	04 02 30.7	27.53	53.45	10.0	4.3
10 06 2020	05 52 10.0	27.00	52.38	10.0	3.5
12 06 2020	04 05 01.6	27.37	53.36	10.0	3.6
13 06 2020	22 04 17.0	27.68	53.29	10.0	4.7
13 06 2020	23 15 06.7	27.57	53.28	10.0	4.3
14 06 2020	18 06 03.2	27.59	53.37	10.0	4.9
17 06 2020	11 50 41.7	29.90	50.59	10.0	4.1
21 06 2020	08 05 42.1	27.93	53.39	10.0	3.4
21 06 2020	21 46 05.2	27.36	56.44	10.0	3.5
23 06 2020	10 49 24.5	27.50	55.88	10.0	3.1
23 06 2020	11 11 07.6	27.36	55.99	10.0	3.2
23 06 2020	23 55 36.1	28.31	58.04	10.0	3.1
25 06 2020	00 13 30.8	27.41	55.75	10.0	3.3
27 06 2020	04 02 04.1	27.95	57.74	10.0	2.9
27 06 2020	05 58 37.1	26.84	56.09	10.0	3.6
27 06 2020	07 28 31.2	27.36	58.06	10.0	2.7
27 06 2020	20 17 04.9	27.44	55.66	10.0	3.1
28 06 2020	01 02 40.8	26.97	56.45	10.0	2.4
29 06 2020	01 57 45.5	27.36	55.52	10.0	2.5
02 07 2020	00 29 21.8	27.60	53.00	08.0	4.0
03 07 2020	03 46 44.5	27.58	53.57	15.0	2.8
04 07 2020	09 04 36.0	27.24	53.52	15.0	3.0
07 07 2020	01 10 35.9	25.77	58.38	30.0	4.3
07 07 2020	17 40 47.8	27.28	53.49	10.0	3.2
07 07 2020	20 20 34.5	27.29	53.56	06.6	2.6
08 07 2020	09 45 54.5	27.01	54.08	15.0	3.2
10 07 2020	06 01 44.2	28.16	56.25	10.0	3.0
10 07 2020	15 41 35.7	28.02	53.22	10.0	2.6
10 07 2020	20 14 07.4	27.64	53.48	10.0	4.4
13 07 2020	01 20 40.1	27.68	58.13	10.0	2.8
13 07 2020	05 18 11.7	29.06	51.95	10.0	3.3
15 07 2020	02 23 29.8	26.71	53.71	10.0	2.8
16 07 2020	02 43 00.8	27.48	54.64	10.0	3.2
19 07 2020	17 44 47.9	26.99	56.40	05.1	2.2

Table 6. Continues

Date D. Mo. Yr.	Origin Time Hr. Mn. Sec.	Locations Lat.°	Long.°	Depth (km)	ML
22 07 2020	18 32 49.6	26.75	54.16	20.0	2.6
23 07 2020	22 23 58.4	26.68	55.21	10.0	2.0
25 07 2020	17 47 08.5	26.98	56.19	02.8	3.4
25 07 2020	17 48 11.1	26.86	56.60	04.1	3.5
25 07 2020	18 24 10.1	26.94	56.63	10.0	1.8
26 07 2020	06 06 30.0	28.20	54.66	10.0	3.2
26 07 2020	06 23 25.8	26.99	56.43	10.0	3.5
27 07 2020	11 12 35.6	26.97	56.46	10.0	4.2
28 07 2020	23 10 29.6	27.29	53.54	10.0	3.5
29 07 2020	21 11 41.5	27.39	56.10	03.0	2.2
30 07 2020	17 34 58.7	27.70	57.01	15.0	2.3
31 07 2020	22 04 15.0	25.82	57.65	15.0	2.2
01 08 2020	02 24 47.2	28.25	57.72	15.0	4.4
01 08 2020	05 00 44.3	25.54	58.14	15.0	2.8
01 08 2020	16 07 08.2	29.64	56.93	30.0	3.5
03 08 2020	11 37 11.4	27.67	52.56	10.0	4.1
03 08 2020	12 34 57.2	27.82	56.40	10.0	3.6
06 08 2020	20 39 48.8	27.23	55.94	02.0	1.7
07 08 2020	00 39 21.1	26.88	56.52	10.0	2.1
11 08 2020	06 31 53.2	28.17	52.10	10.0	3.7
11 08 2020	17 52 18.0	27.65	56.42	10.0	3.0
14 08 2020	13 41 16.2	28.35	52.33	15.0	2.7
18 08 2020	09 14 45.4	26.95	55.45	10.0	2.2
19 08 2020	22 13 53.1	28.52	51.62	15.0	3.4
22 08 2020	18 40 24.7	28.20	56.61	10.0	3.6
25 08 2020	12 16 06.6	27.37	53.19	10.0	4.4
25 08 2020	21 19 03.0	28.04	55.04	10.0	3.6
26 08 2020	00 01 10.0	29.15	50.66	10.0	3.9
27 08 2020	11 10 18.2	27.10	55.92	10.0	2.4
27 08 2020	21 42 30.4	27.36	55.74	10.0	3.4
27 08 2020	22 50 05.0	26.45	55.07	10.0	2.6
30 08 2020	01 26 14.6	27.50	55.58	15.0	2.8
30 08 2020	21 29 03.3	29.62	57.49	10.0	4.1
31 08 2020	03 36 54.0	27.73	53.23	10.0	5.1
31 08 2020	15 57 25.1	27.59	53.39	10.0	3.7
01 09 2020	11 21 46.4	26.39	55.06	03.7	2.8
01 09 2020	15 11 39.7	28.34	57.29	27.0	3.3
02 09 2020	18 03 27.9	28.24	56.60	10.0	3.6
02 09 2020	18 11 36.1	28.32	56.46	20.0	3.4
03 09 2020	08 34 35.8	26.80	55.73	10.0	3.1
03 09 2020	17 50 59.9	26.50	55.05	10.0	2.9
06 09 2020	10 21 59.7	29.13	52.01	10.0	3.9
07 09 2020	02 16 00.9	27.16	56.03	10.0	2.8

Table 6. Continues

Date D. Mo. Yr.	Origin Time Hr. Mn. Sec.	Locations Lat.°	Long.°	Depth (km)	ML
07 09 2020	22 30 36.1	26.17	58.38	10.0	2.7
08 09 2020	01 34 22.1	27.57	53.21	10.0	3.9
08 09 2020	19 54 12.0	27.43	55.57	10.0	2.8
09 09 2020	10 42 49.7	27.67	56.25	10.0	4.2
09 09 2020	11 02 42.7	27.51	55.70	10.0	2.8
11 09 2020	13 11 32.0	27.27	54.97	10.0	2.8
13 09 2020	21 03 58.0	27.52	57.41	15.0	2.8
14 09 2020	01 36 08.2	26.79	54.91	15.0	2.9
14 09 2020	09 26 08.5	27.42	54.40	10.0	3.8
14 09 2020	19 36 28.9	27.19	56.03	06.0	2.7
18 09 2020	04 14 33.5	29.03	50.30	15.0	3.6
19 09 2020	17 01 37.5	27.62	53.30	10.0	3.5
19 09 2020	17 38 14.7	27.64	56.46	10.0	3.1
22 09 2020	19 43 33.4	27.31	55.37	10.0	4.1
24 09 2020	13 15 18.5	29.36	51.57	10.0	4.4
25 09 2020	20 17 04.6	26.98	56.40	10.0	2.2
27 09 2020	23 23 42.1	28.55	51.52	10.0	4.8
28 09 2020	07 13 03.6	27.77	57.32	15.0	2.8
28 09 2020	08 11 53.8	28.60	51.64	15.0	4.0
28 09 2020	10 02 18.1	27.69	53.23	15.0	3.2
03 10 2020	19 07 39.1	27.45	56.59	15.0	3.0
05 10 2020	04 32 56.9	27.06	56.49	03.5	3.4
06 10 2020	21 15 47.5	26.40	59.06	15.0	2.9
09 10 2020	15 26 25.3	28.12	56.48	30.0	4.0
14 10 2020	11 06 13.0	27.71	54.39	10.0	3.9
14 10 2020	17 51 24.6	27.49	54.56	10.0	2.9
14 10 2020	18 18 32.2	27.65	56.48	10.0	3.2
15 10 2020	13 36 51.5	28.47	56.63	10.0	3.2
18 10 2020	20 41 46.2	27.21	56.88	10.0	3.2
24 10 2020	08 01 33.3	27.61	57.02	10.0	3.4
25 10 2020	09 44 28.9	27.15	53.18	33.2	3.2
26 10 2020	17 28 10.3	27.63	54.51	10.0	3.7
26 10 2020	19 17 04.1	27.46	54.51	10.0	3.0
26 10 2020	20 24 54.5	27.59	54.49	15.0	3.3
28 10 2020	11 13 24.9	28.63	55.87	15.0	2.8
28 10 2020	18 56 17.4	28.19	53.23	10.0	3.1
30 10 2020	19 22 45.5	26.79	54.32	10.0	3.0
02 11 2020	01 38 42.4	28.51	51.43	10.0	3.8
02 11 2020	22 32 14.3	28.24	55.81	12.0	2.9
03 11 2020	00 11 45.3	28.83	51.66	12.0	4.3
04 11 2020	06 18 45.9	28.50	57.45	30.0	3.5
05 11 2020	04 05 44.8	27.13	53.54	10.0	3.8
05 11 2020	16 55 57.5	28.41	57.40	10.0	3.4

Table 6. Continues

Date D. Mo. Yr.	Origin Time Hr. Mn. Sec.	Locations Lat.°	Long.°	Depth (km)	ML
08 11 2020	14 41 12.6	27.30	53.57	10.0	3.7
08 11 2020	21 51 18.8	27.38	53.57	10.0	3.4
09 11 2020	11 49 21.9	27.32	53.60	10.0	3.3
10 11 2020	21 29 04.1	29.65	57.25	10.0	3.6
11 11 2020	01 26 46.7	26.88	54.97	10.0	3.9
13 11 2020	04 31 15.2	26.59	57.37	10.0	2.5
15 11 2020	22 06 35.2	27.03	53.78	10.0	3.2
17 11 2020	00 58 17.0	27.13	54.21	10.0	2.8
17 11 2020	10 15 01.8	28.91	55.08	10.0	3.3
17 11 2020	22 41 07.9	27.68	59.56	10.0	4.5
18 11 2020	13 00 01.7	26.98	55.87	00.0	3.6
19 11 2020	19 43 34.9	27.05	57.90	10.0	3.1
22 11 2020	01 20 37.5	27.13	53.55	10.0	3.4
22 11 2020	04 13 58.9	27.15	53.60	10.0	4.1
22 11 2020	21 28 35.3	27.54	56.07	10.0	3.5
24 11 2020	14 27 28.8	27.27	54.45	10.0	2.9
29 11 2020	04 24 28.8	27.45	54.14	10.0	4.7
04 12 2020	20 40 22.7	28.64	57.81	20.0	3.5
07 12 2020	11 31 40.5	28.28	52.34	15.0	3.7
08 12 2020	07 28 48.6	28.30	53.71	15.0	3.9
11 12 2020	19 56 59.8	26.80	54.20	10.0	2.4
11 12 2020	20 47 54.3	27.47	54.07	10.0	4.1
16 12 2020	04 27 21.9	26.65	53.74	10.0	2.6
24 12 2020	12 59 15.7	27.05	54.40	10.0	2.7
25 12 2020	08 23 40.6	26.94	58.16	10.0	2.7
26 12 2020	12 11 49.7	27.36	54.54	10.0	3.0
29 12 2020	22 15 59.8	28.24	56.45	10.0	3.3
29 12 2020	22 18 41.0	28.17	56.37	10.0	3.1