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Hybrid long-period volcanic events observed in off Nicobar region, the Andaman Sea from a passive OBS experiment

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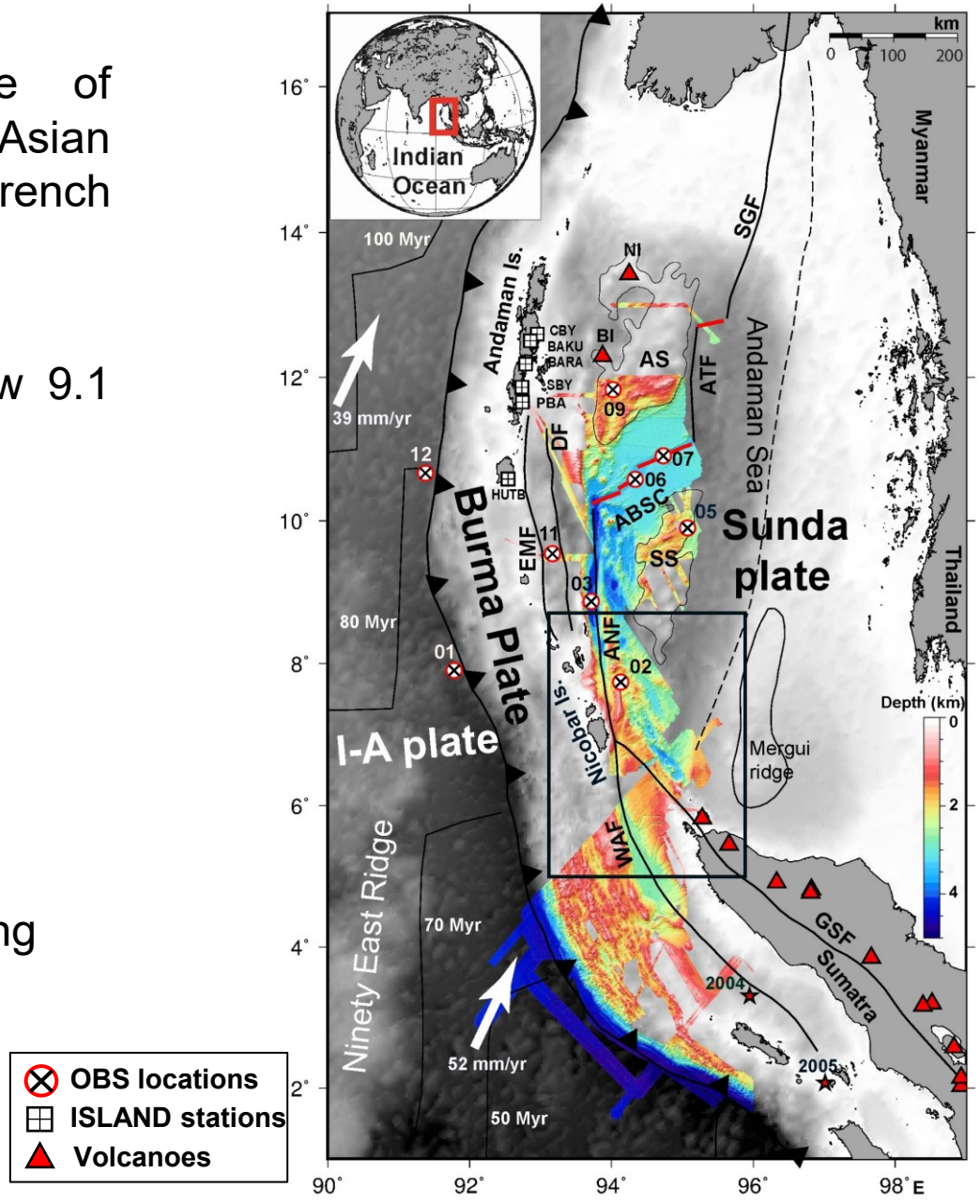
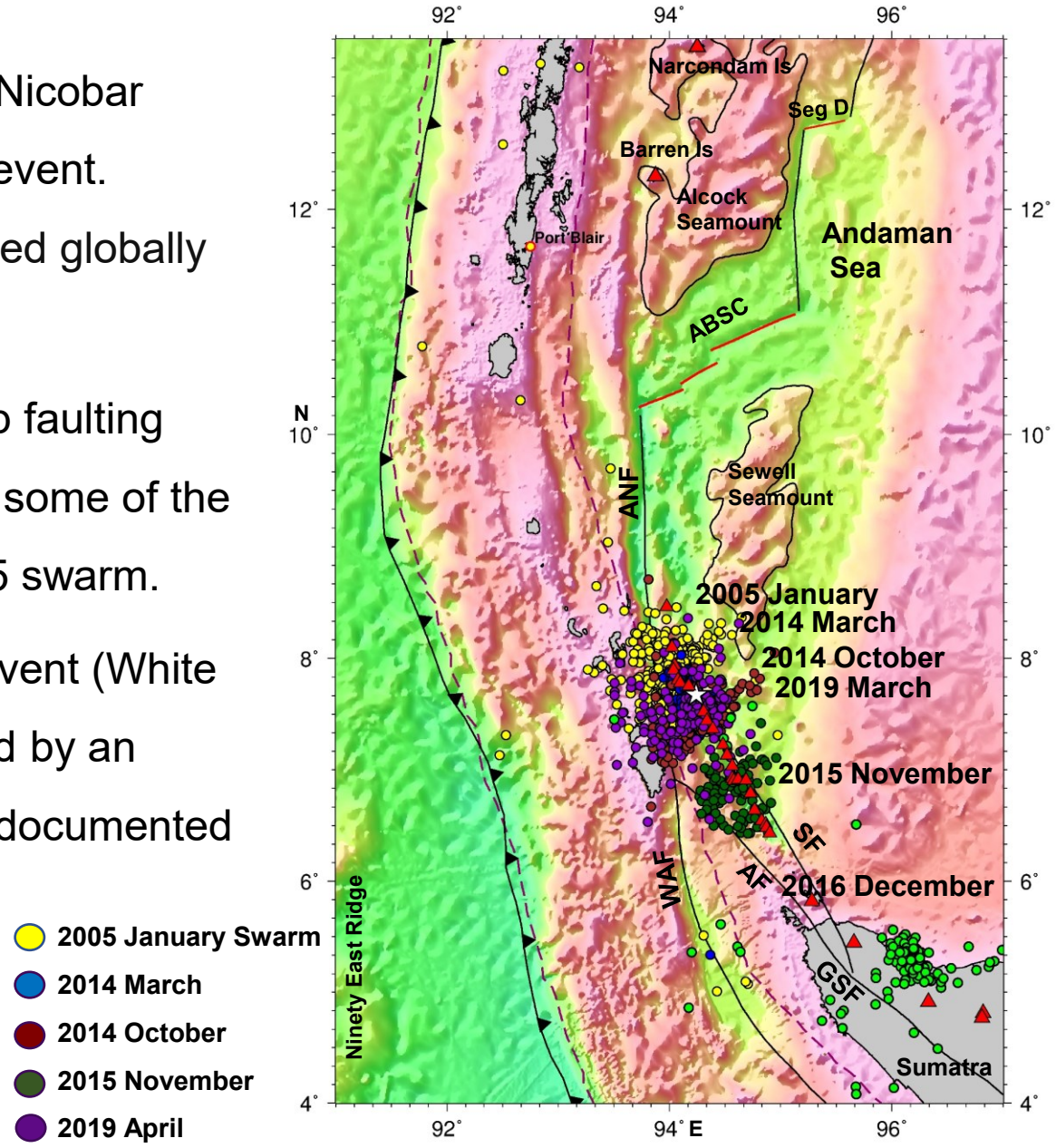
Study Area : NE Indian Ocean special reference to Andaman Sumatra Subduction zone

- Boundary of NE Indian Ocean defines zone of underthrusting of the Indian plate below the Southeast Asian plate, leading to the formation of a major island arc-trench system.
- This is the most tectonically active area.
- Recent mega earthquake event – 2004 Dec 26, Mw 9.1 Sumatra Andaman Earthquake
- Major fault systems
    1) Andaman Nicobar Fault (ANF)
    2) West Andaman Fault (WAF)
    3) Great Sumatra Fault (GSF)
- Data used for this study
    1) Ocean Bottom Seismometer data (Deployed during 26th December 2013- 14 May 2014)
    2) ISLANDS network data



Significant earthquake swarms occurred off Nicobar Island

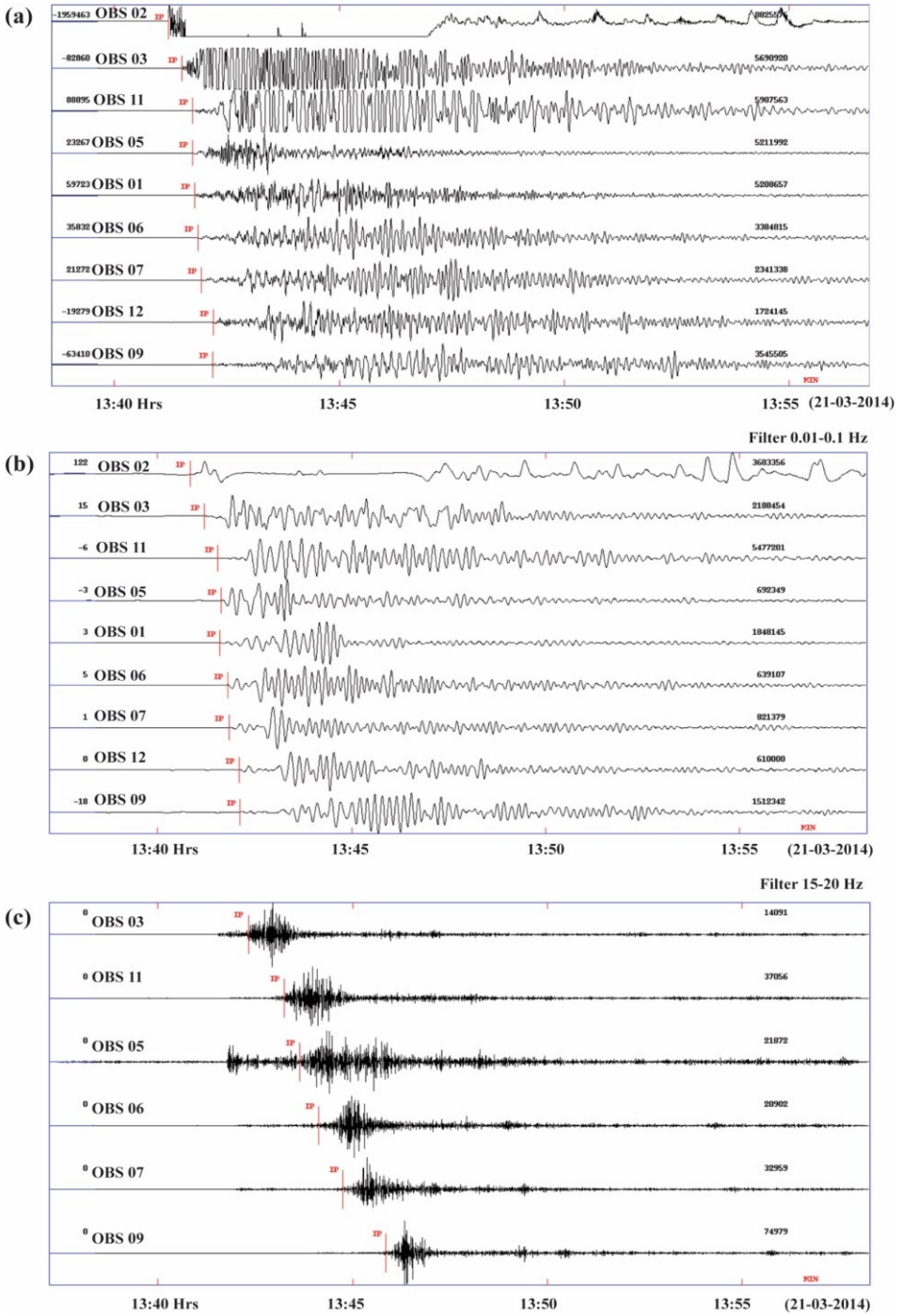
- Earthquake swarms are observed frequently in the off Nicobar region after 26th December tsunamigenic mega thrust event. January 2005 is the most energetic swarm ever recorded globally (Lay et al., 2005).
- Stress changes due to the megathrust event, strike-slip faulting and submarine volcanism in the off Nicobar region are some of the possible reasons suggested for the occurrence of 2005 swarm.
- After 2005 March, on 21st March 2014 (6.5 M_w) large event (White star in the figure) happened Off Nicobar region followed by an earthquake swarm (blue circles). This event has been documented in OBS data.



Hybrid long-period events observed in off Nicobar region during 21st– 22nd March 2014 in Passive OBS Experiment

Results :

- Detected a series of hybrid earthquake events initiated by high–frequency (5-10 Hz) P-onset followed by a low frequency (0.01-0.1 Hz) very long-period signal, with no seismic phases.
- Observed a prominent high frequency (10-40 Hz) hydro-acoustic phase (similar to T phase detected by continental stations) in the hydrophone component of OBS unit.
- Several studies suggest that the low frequency events and hydroacoustic waves are the main geophysical constrain to study the volcanic activity (Chouet et al., 1994; McNutt, 2004; Chouet & Matoza, 2013, Ewing et al., 1946; Talandier & Okal, 1987, 1996; Okal, 2001).



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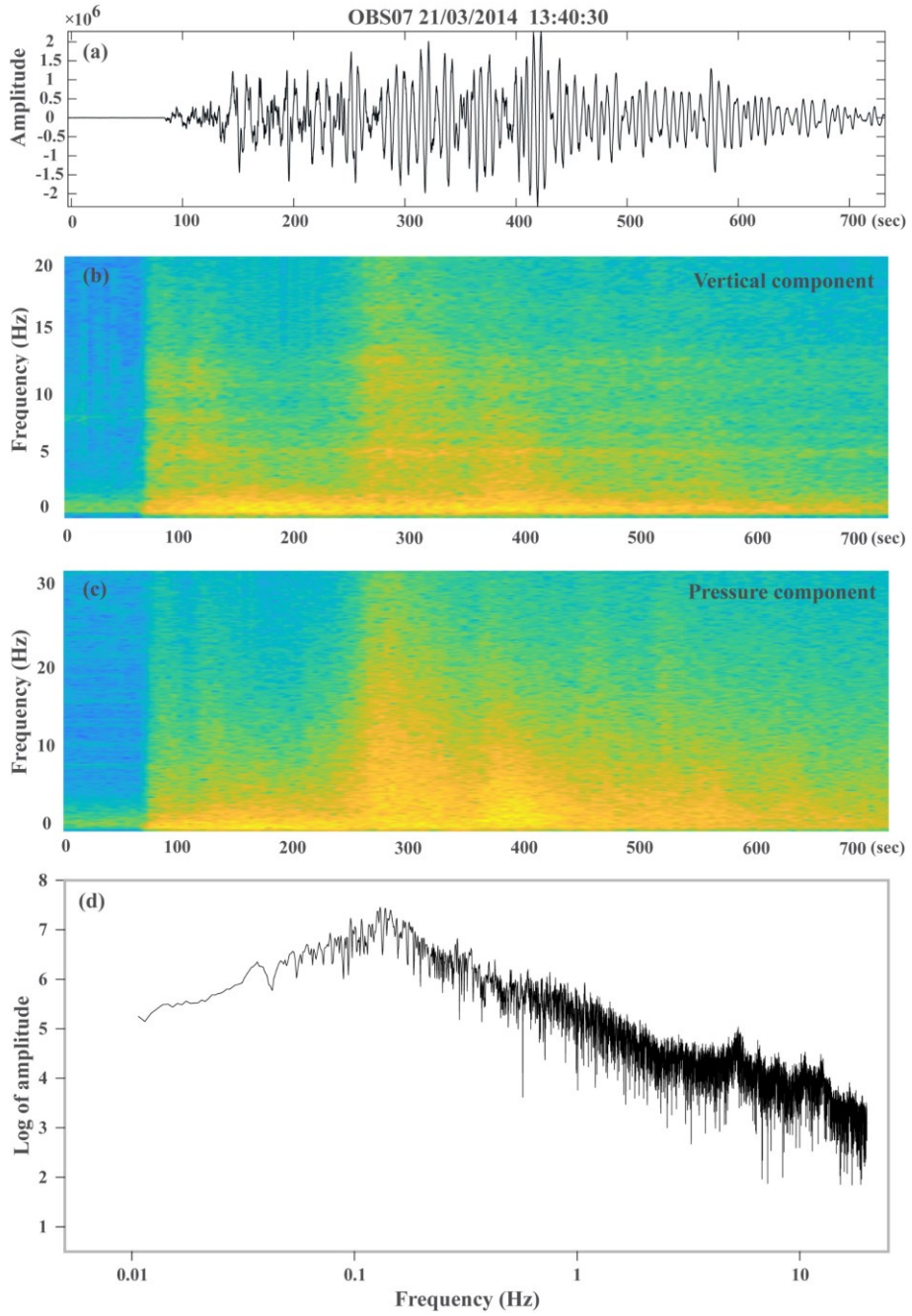
- Spectrogram of vertical component of waveform data depicts a hybrid earthquake event, an example of the event from OBS07 is shown in Figure.
- A very-high frequency hydro-acoustic signal is observed in the middle of low-frequency oscillations in the pressure component.
- The spectrum of the vertical component shows a spectral peak at 0.13 Hz



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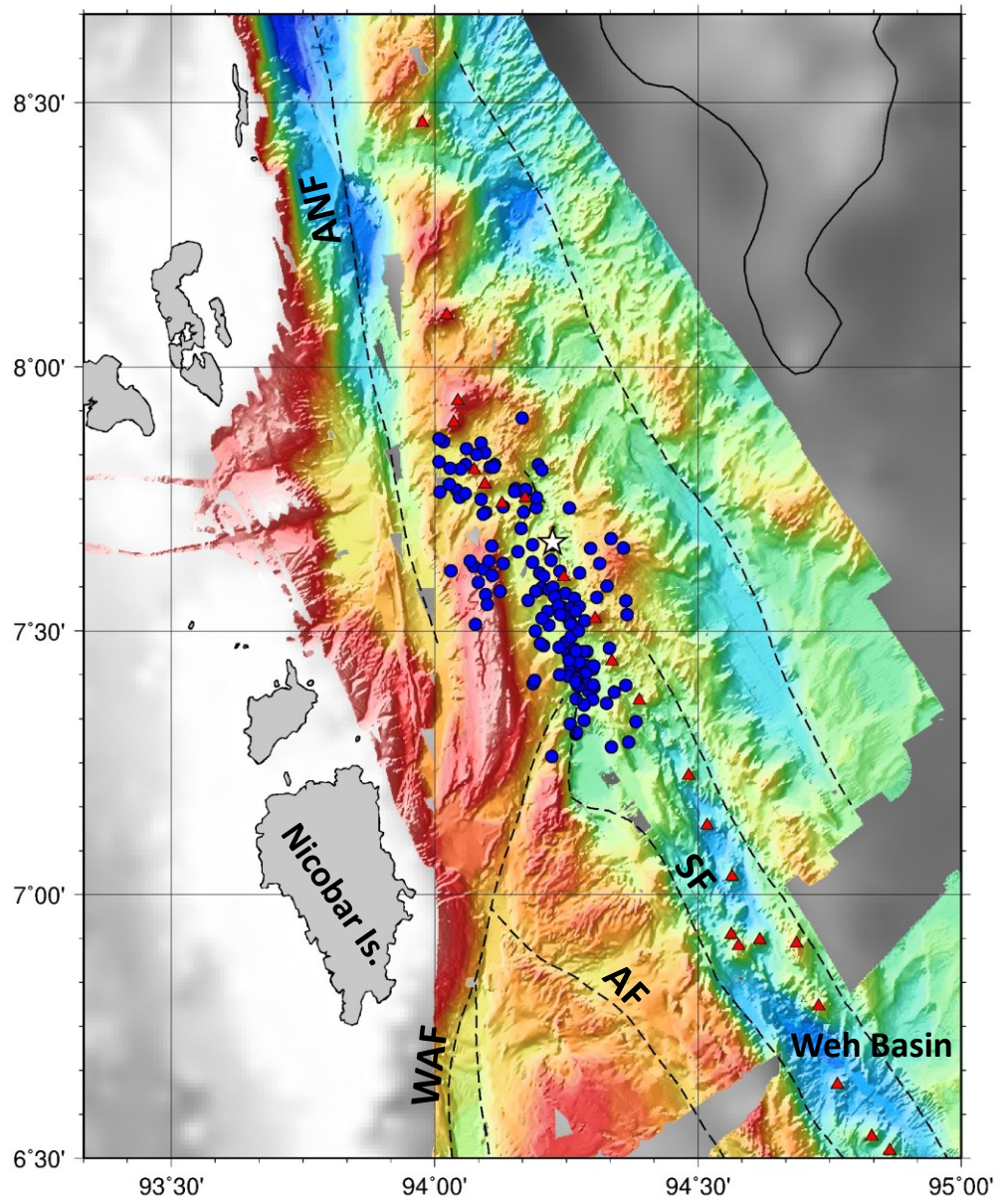
- We have identified and located 141 high-frequency events on 21st and 22nd March 2014 using hypocent v.3.2 program.
- They are distributed along NW-SE direction aligning with the submarine volcanoes defining the volcanic arc and strike of local fault system present in the region as observed in the high-resolution bathymetry data.



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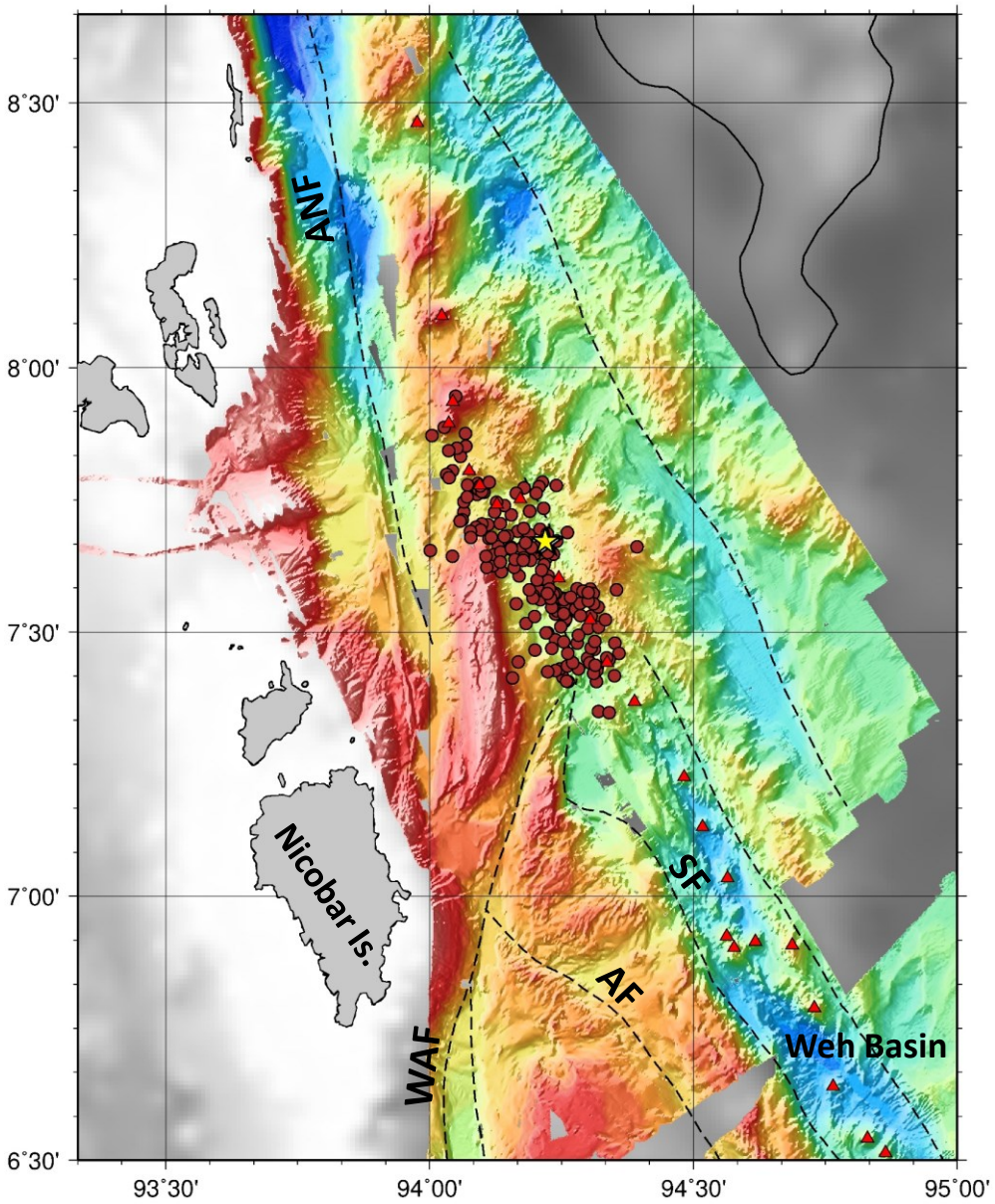
- Located 180 events using high-frequency hydroacoustic events on 21st and 22nd March 2014 by using water velocity in hypocent v.3.2 program.
- They are also distributed along NW-SE direction aligning with the submarine volcanoes defining the volcanic arc as observed in the high-resolution bathymetry data.



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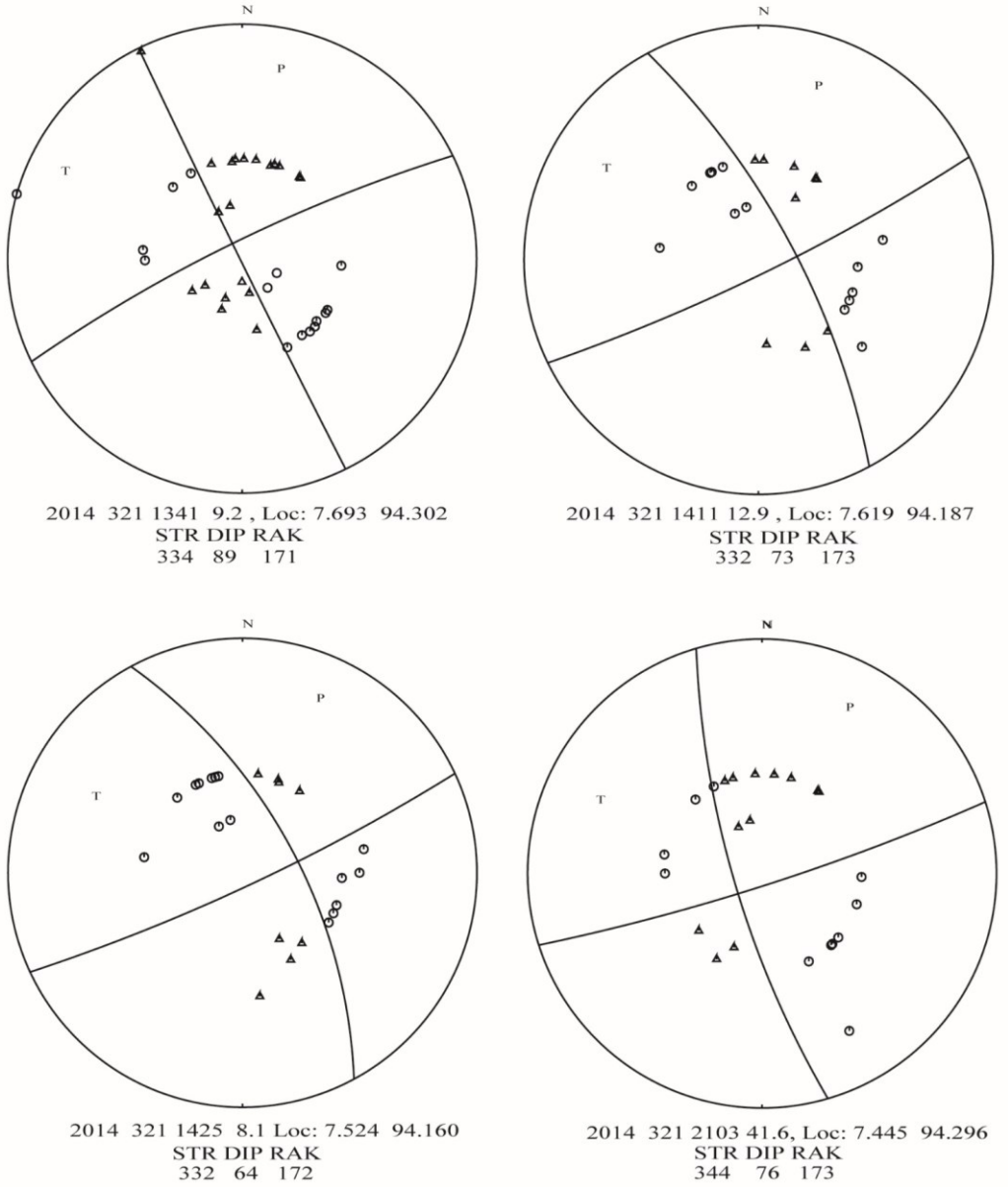
- The fault plane solution of the major high-frequency events suggests strike-slip faulting with strike, dip and rake values of 334˚, 89˚ and 171˚, respectively.
- The strike direction is complement along the strike of the direction of the prevalent sliver strike-slip faulting in the Andaman back-arc region.



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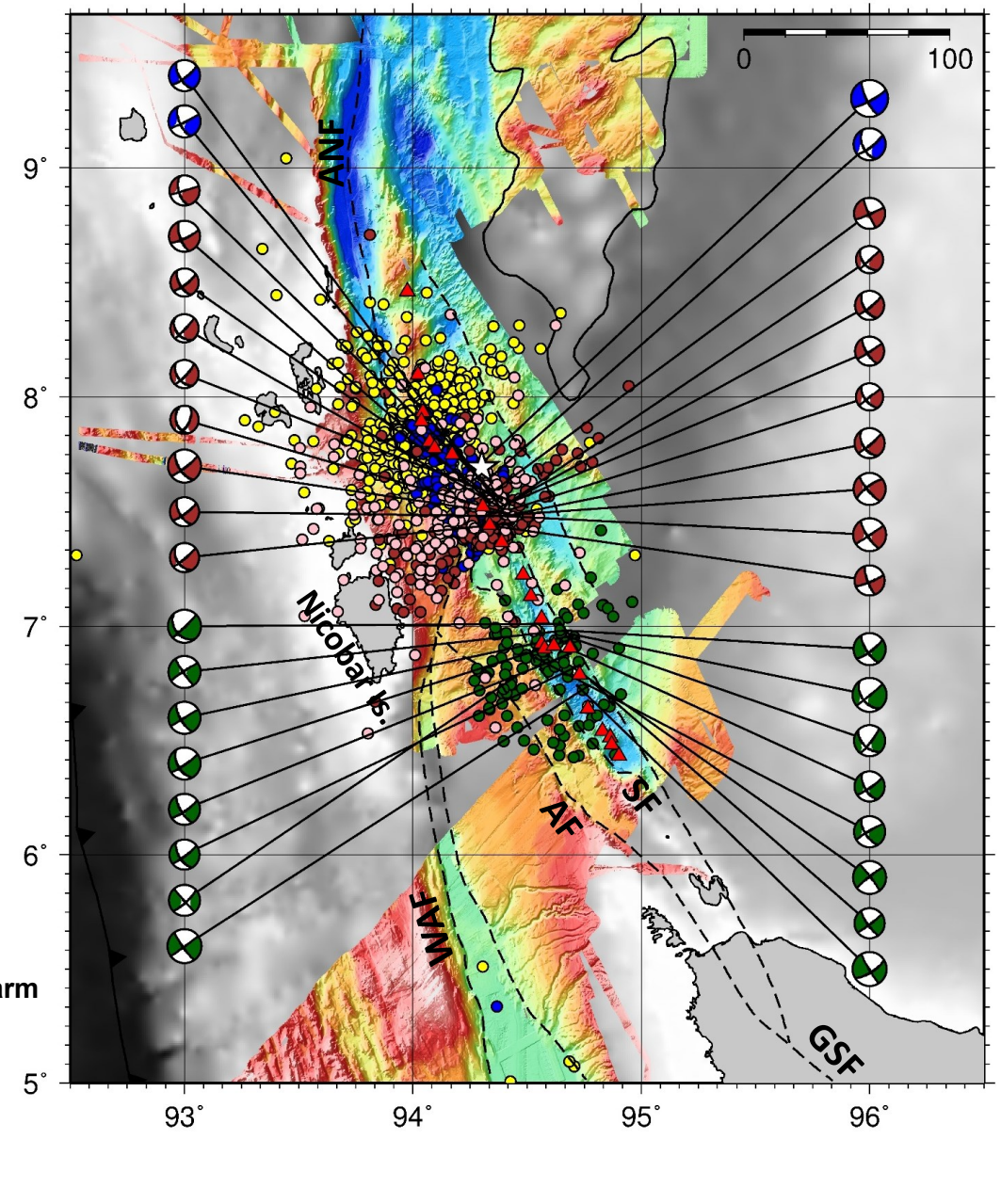
- The focal mechanisms of 2014, 2015, 2019 swarms, obtained from GCMT (Global Centroid Moment Tensor, https://www.globalcmt.org/) catalogue, also suggest strike-slip fault earthquakes similar to 2014 March event.
- The 6.5 M_W earthquake event on 21st March 2014 rejuvenated the northern segment of SF, and triggered other swarms in the off Nicobar region in October 2014, November 2015 and March 2019.



Conclusion

1) The onset of waveform shows a high–frequency (1-10 Hz) earthquake event which is followed by a long-period waveform up to 600 s. The occurrence of long period events indicates the subsurface movement of magma near the inner volcanic arc, Off Nicobar region, Andaman Sea.

2) The onset earthquake occurs at shallow depths and the focal mechanism indicates right-lateral strike-slip faulting. The epicenters are distributed along the Northern segment of Great Sumatra Fault.

3) We also observed very high-frequency (10-40 Hz) hydro-acoustic phase in the coda of long period event. The earthquake swarms and associated hydro-acoustic phase indicate sub-surface magma movement and possibly a surface eruption of submarine volcanoes in the off Nicobar region.

4) The 6.5 M_W earthquake event on 21st March 2014 rejuvenated the northern segment of SF, and triggered other swarms in the off Nicobar region in October 2014, November 2015 and March 2019.

Thank You