SnT 2023

CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

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SYSTEMATIC SEISMIC EVENTS DISCRIMINATION AT THE KENYA NATIONAL DATA CENTRE (KE-NDC)

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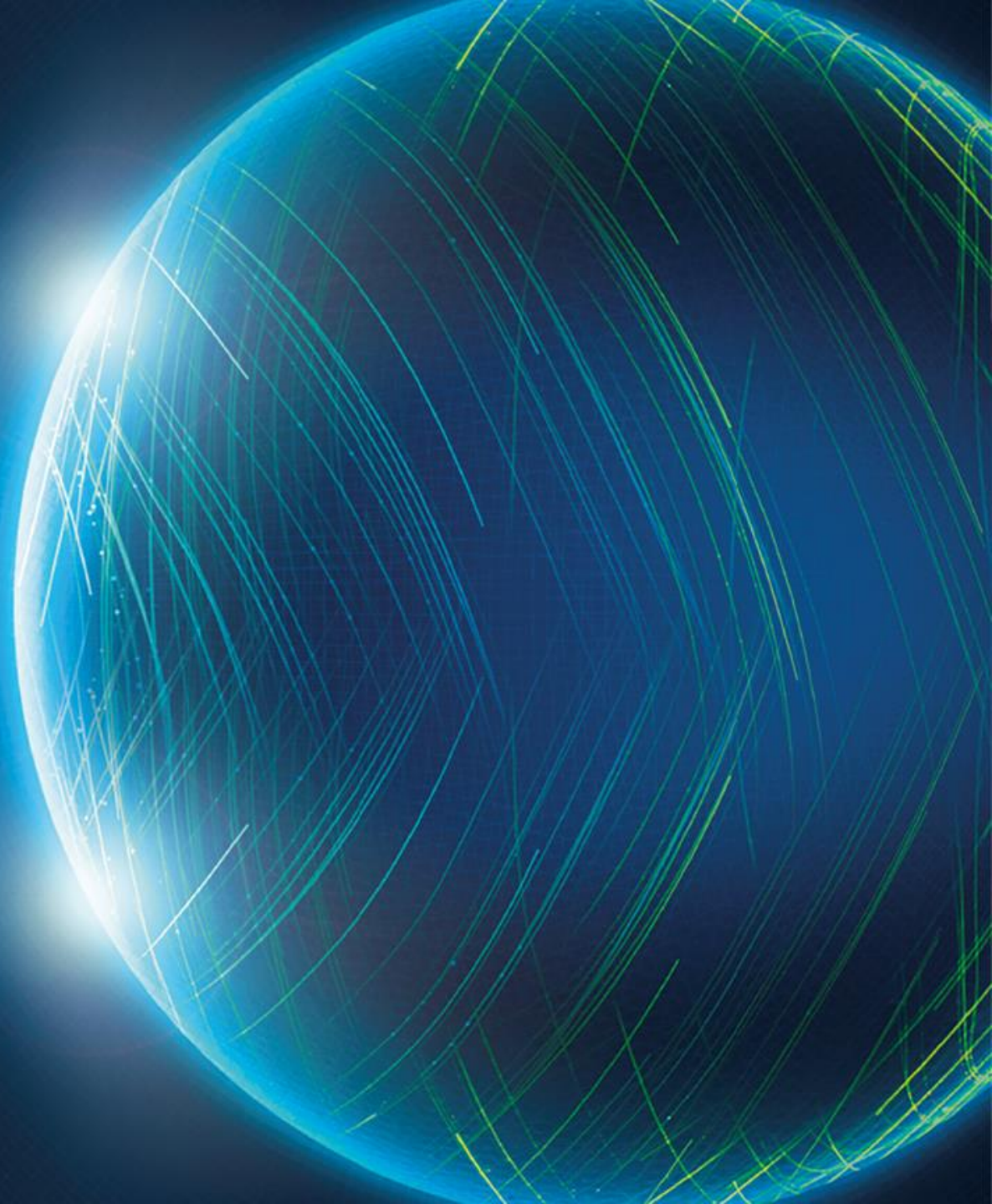
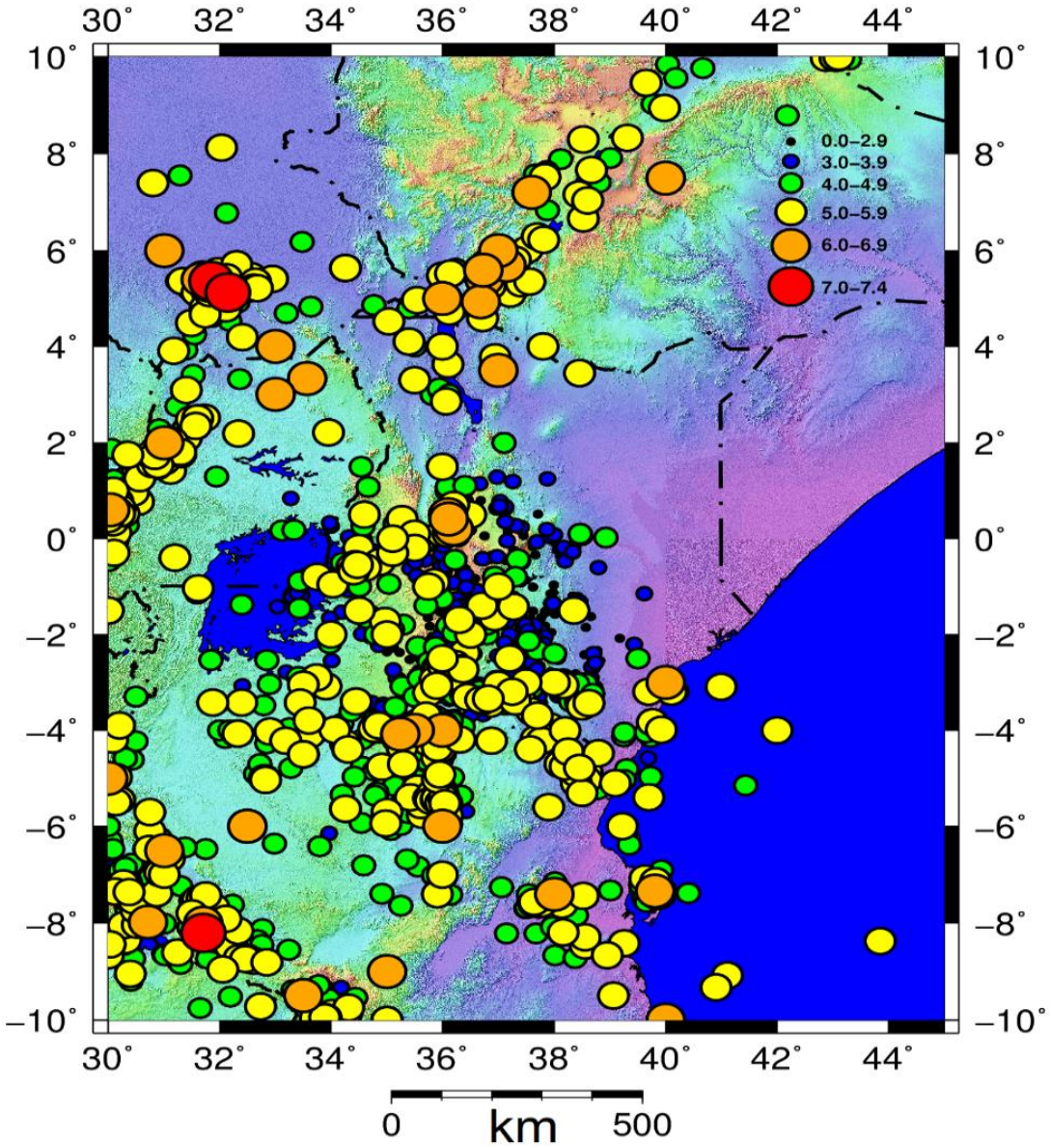


Outline of Presentation

- Background information
- Seismic events discrimination methods and their ranking at KE-NDC
- Examples of seismic event discrimination
- Conclusion and Recommendation
- Acknowledgement

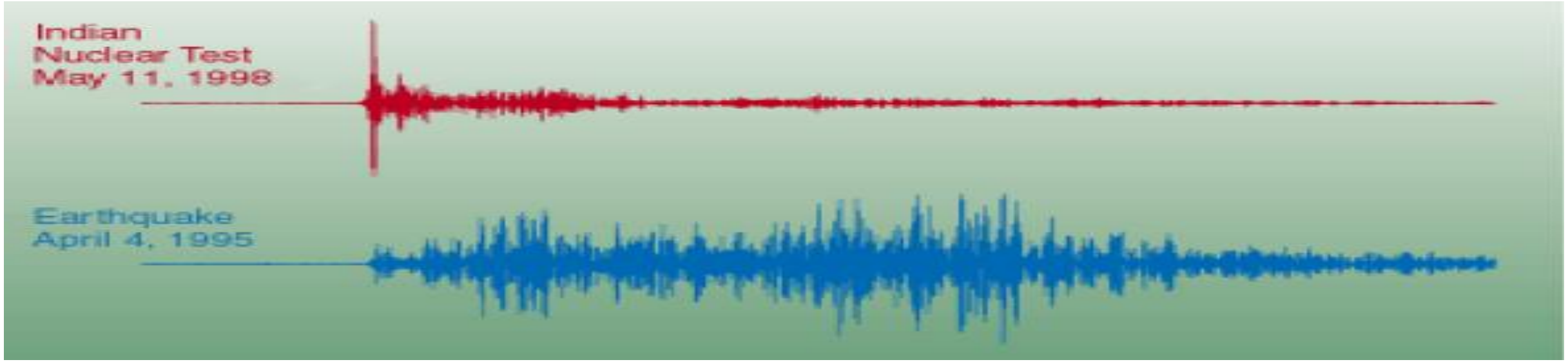
1. Background Information



Seimicity for the period 1900-2020

- IDC routinely applies event screening or discrimination using a multi-technology approach in order to characterize events as either natural or anthropogenic.
- At KE-NDC, a step by step procedure for events discrimination is applied to seismic events.
- Results are obtained within a short time and the hierarchy of discriminants is dependent on their ease of use.

2. Seismic Event Discriminants



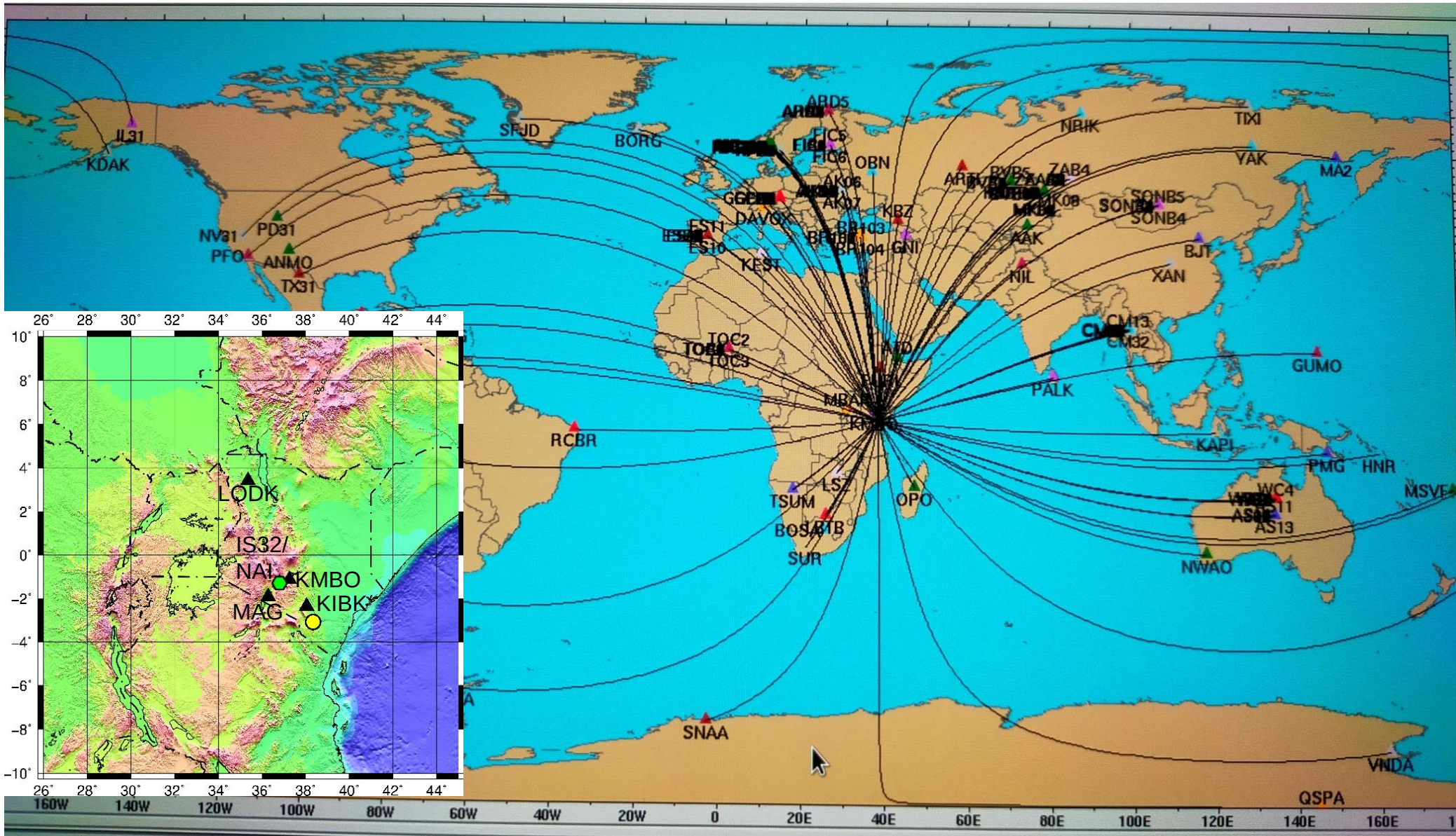
Rogers and Koper (ND): Forensic Seismology

- ✓ Event location (Epicenter/Hypocenter parameters)
- ✓ Magnitudes (>=3.0)
- ✓ Relocate to refine depth (HYP)
- ✓ mb : Ms criteria
- ✓ Focal mechanism (FOCMEC)

- ❖ SP Discriminants - Complexity, Spectral Ratio and TMF
- ❖ Regional P/S amplitude ratios
- ❖ Lg Spectral amplitude ratios
- ❖ Coda decay rates
- ❖ Moment Tensor Inversion
- ❖ Waveform Inversion (modeling)

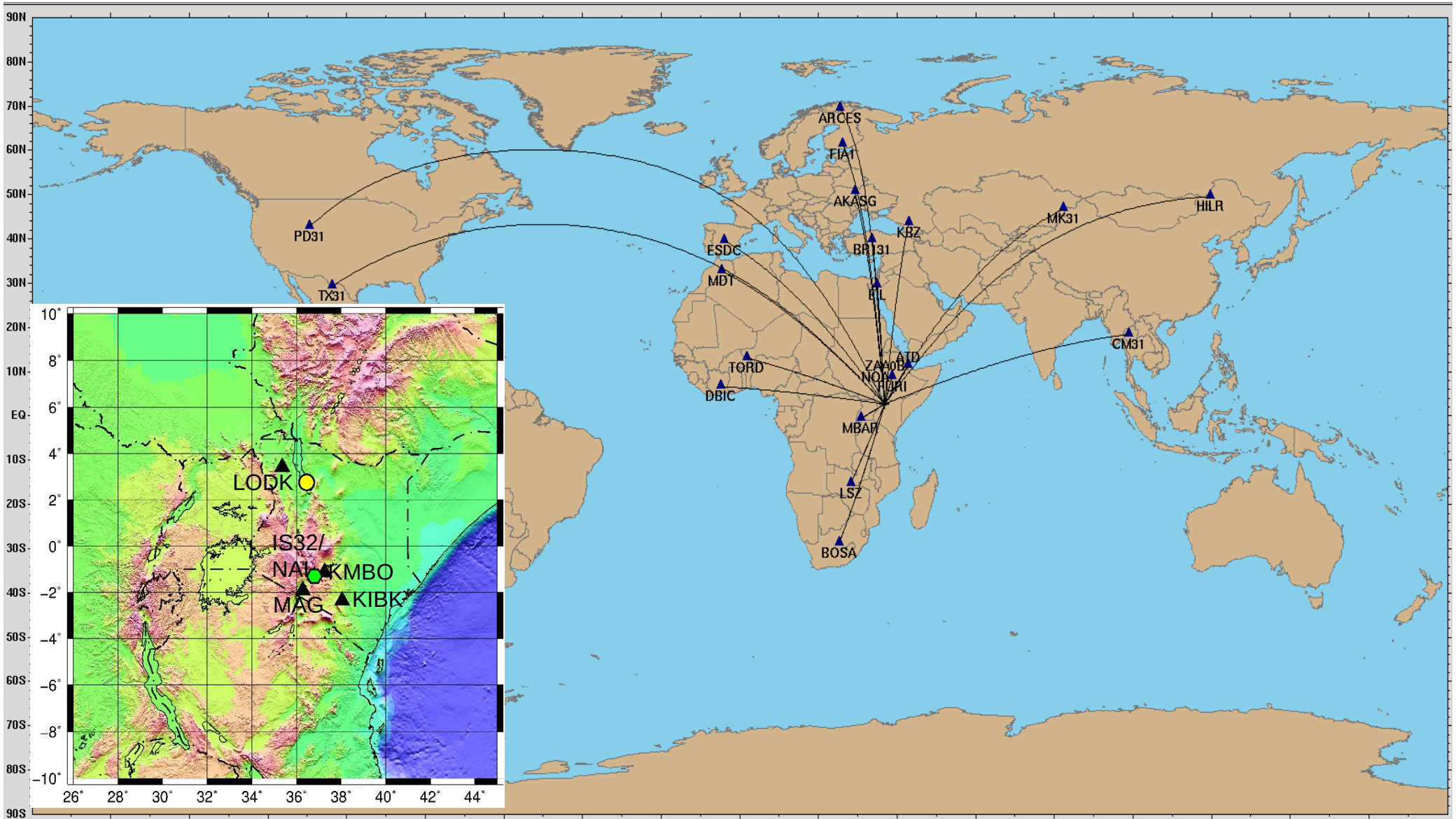
3. The 20190324 Chyulu Hills seismic event

Lat: -3.0807
Lon: 38.3428
Depth: 0 km
mb: 4.2



3. The 20200503 Lake Turkana seismic event

Lat: 2.7577
Lon: 36.4563
Depth: 0 km
mb: 4.8



4. The 20190324 Event Hypocenter Determination (Re-location)

Hypocenter solution

Latitude	Longitude	Date and Origin time (UTC)	Depth (km)	Magnitude ml mb	Number of seismic stations	Region
-3.117	38.362	20190324 16:21:11	9.1	4.9 4.2	57 (3 non-IMS)	Chyulu hills in SW Kenya

NIAB solution

Latitude	Longitude	Date and Origin time (UTC)	Depth (km)	Magnitude ml mb	Number of seismic stations	Region
-3.0807	38.3428	20190324 16:21:13	0.0	4.9 4.2	54	Chyulu hills in SW Kenya

If depth >= 10 km, may be an earthquake

4. The 20200503 Event Hypocenter Determination (Re-location)

Hypocenter solution

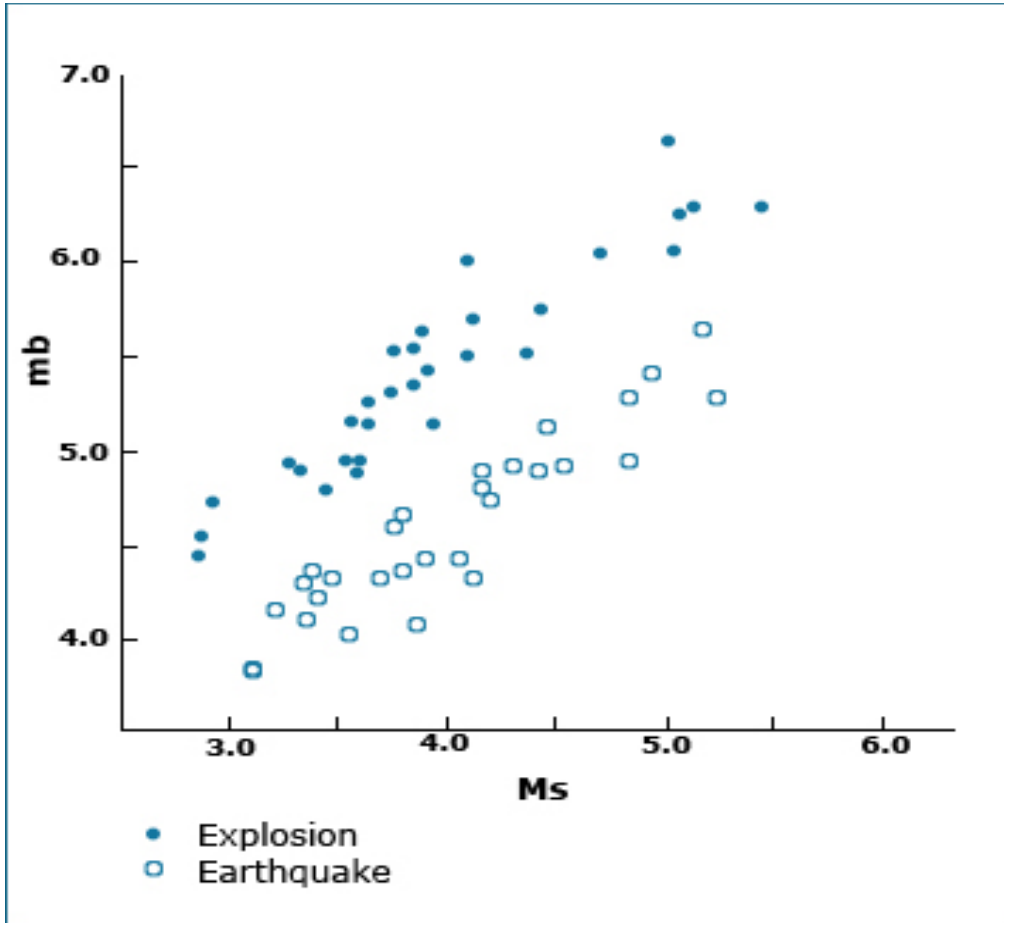
Latitude	Longitude	Date and Origin time (UTC)	Depth (km)	Magnitude ml mb	Number of seismic stations	Region
2.8550	36.2540	20200503 19:36:55	14.1	4.8 4.8	35 (2 non-IMS)	Turkana Depression, Northern Kenya

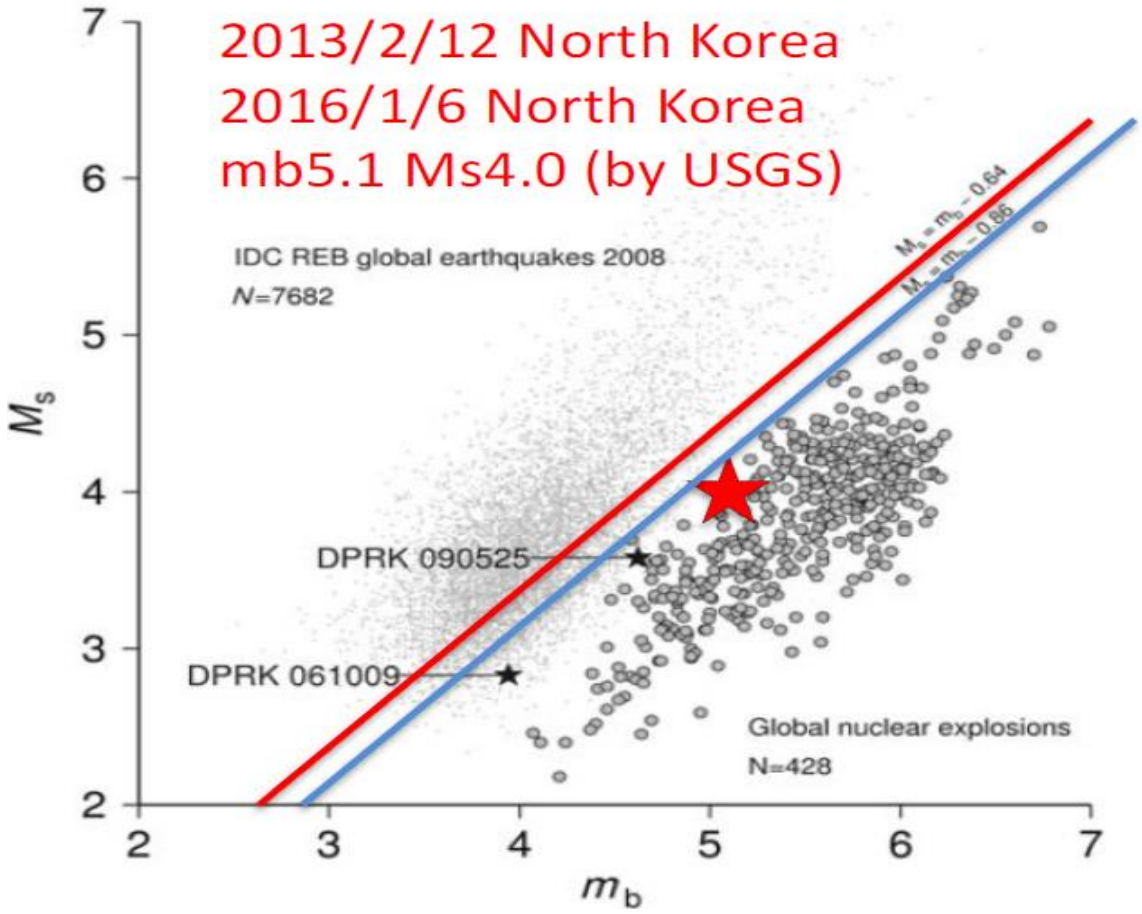
NIAB solution

Latitude	Longitude	Date and Origin time (UTC)	Depth (km)	Magnitude ml mb	Number of seismic stations	Region
2.7577	36.4563	20200503 19:36:53	0.0	4.8 4.8	33	Turkana Depression, Northern Kenya

If depth >= 10 km, may be an earthquake

5. mb : Ms Criteria





1.25 m_b(IDC) - M_s(IDC)=2.20

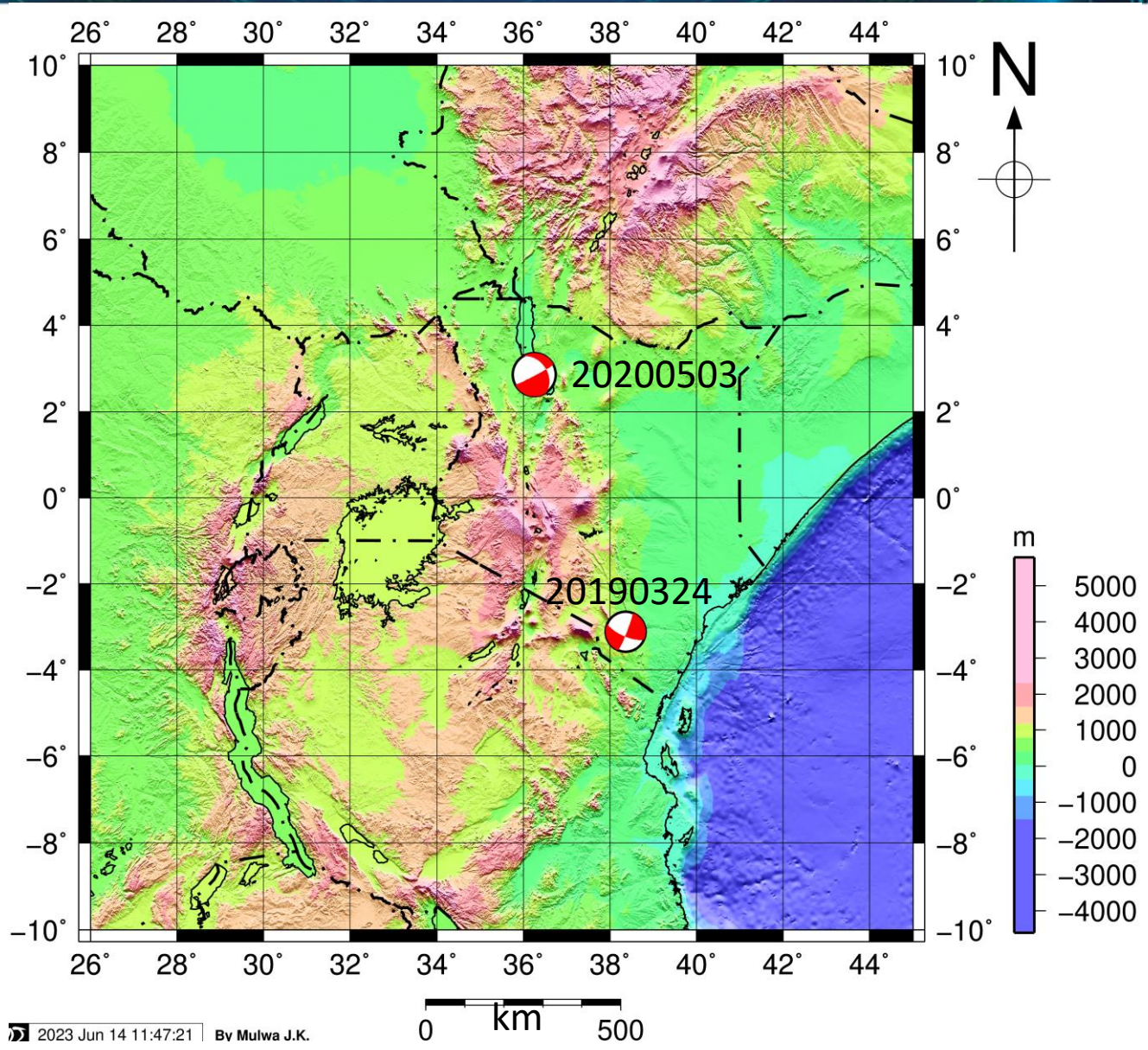
m_b = 4.2; M_s = 3.1 (20190324); m_b = 4.8; M_s= 3.8 (20200503)

6. Focal Mechanism (FOCMEC) determination

- Determines and displays double-couple earthquake focal mechanism;
- Performs efficient systematic search of focal sphere;
- Reports acceptable solutions based on selection criteria for the number of polarity and/or amplitude errors

Snoke, J.A., 2017. FOCMEC: FOCal MEChanism Determinations

6. Focal Mechanism (FOCMEC) Solution



7. Next steps for indeterminate solution

- ✓ Event location (Epicenter/Hypocenter parameters)
- ✓ Magnitudes (>=3.0)
- ✓ Relocate to refine depth using Hypocenter (HYP)
- ✓ mb : Ms criteria
- ✓ Focal mechanism (FOCMEC)

Mb : Ms Amplitudes

- ❖ Measure body wave and surface wave amplitudes
- ❖ Compute mb and M_s magnitudes

$$m_B = \log_{10}(A/T) + q(\triangle, h)$$ Gutenberg, 1945a,b

$$Ms = \log_{10} A + 1.656 \log_{10} \triangle + 1.818$$ Gutenberg, 1945c

7. Next steps for indeterminate solution (mb-Ms Amplitudes)

mb Computation (DBIC)				Ms Computation (CHTOlhz)	
Amplitude (A)	Maximum (crest)	7.53616E-02		Maximum (Crest)	33.2892
	Minimum (Trough)	-9.72740E-02		Minimum (Trough)	-35.6477
	2*Amplitude	1.72636E-01		2*Amplitude	68.9369
	Amplitude (nm)	8.63178E-02		Amplitude	34.46845
	Amplitude (µm)	8.63178E-05		Amplitude	0.03446845
Period (T)	From (sec)	54.026		From (sec)	36.849
	To (sec)	54.369		To (sec)	49.704
	Period (sec)	0.343		Period (sec)	12.855
	2*T	0.686			
Focal Depth (h km)	30				
Delta (Δ, deg)	8.00E+01			Delta (Δ, km)	2.80E+01
q	6.8				
mb	5.90E+00			Ms	6.13E+00

8. Conclusion and Recommendation

Conclusion

- A variety of methods and techniques for seismic events discrimination are available to NDCs
- At KE-NDC, we have developed a hierarchy of seismic event discriminants based of ease of use and ability to obtain results in the shortest time.
- Moment tensor inversion and waveform modeling form KE-NDC's ETA

Recommendation

- IDC to consider incorporating seismic event discrimination methods in NDC Capacity Building: Advanced Technical training courses on Access and Analysis of waveform IMS data and IDC products.

9. Acknowledgement

The Comprehensive Nuclear Test-Ban Treaty Organization (CTBTO)

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Japan International Cooperation Agency (JICA)