# The International Association for Structural Geology and Tectonics Conference

## Accra, Ghana, 22-24 July, 2026

ex solo ad solem, वसुधैव कुटुम्बकम्
ex solo ad solem, Vasudhaiva Kutumbakam
from the earth to the sun, the world is one family

# Tectonic Controls on Seismicity in Southern Ghana


Saviour Morkley, Thomas Armah, Paulina E. Amponsah, Sylvanus T. Ahulu, | Department of Earth Science, University of Ghana, Legon, Accra
Eric D. Forson | Department of Physics, University of Ghana, Legon, Accra


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**KEY FINDING:** Southern Ghana's seismicity is structurally controlled — ancient Precambrian faults along the WAC margin are reactivated by stress transmitted from the Mid-Atlantic Ridge via the Romanche and St. Paul fracture zones.

## BACKGROUND

Ghana lies within the stable West African Craton (WAC), yet southern Ghana experiences recurrent moderate earthquakes — an apparent paradox explained by tectonic inheritance.

- Most of Ghana is underlain by stable Archean–Paleoproterozoic cratonic rocks
- SE Ghana falls within the Pan-African Mobile Belt — reworked during Neoproterozoic orogenesis
- Offshore: Romanche & St. Paul fracture zones transmit Mid-Atlantic Ridge stress toward the Ghanaian coast
- Persistent low-to-moderate intraplate seismicity recorded since 1615 AD

## RESEARCH OBJECTIVES

- Synthesise tectonic frameworks linking offshore fracture zones to onshore fault reactivation
- Compile & analyse earthquake catalogues from previous analog and current digital seismograph network (1615–2023 and 2012 -2023)
- Map spatial clustering of epicentres relative to known fault systems

## STUDY AREA

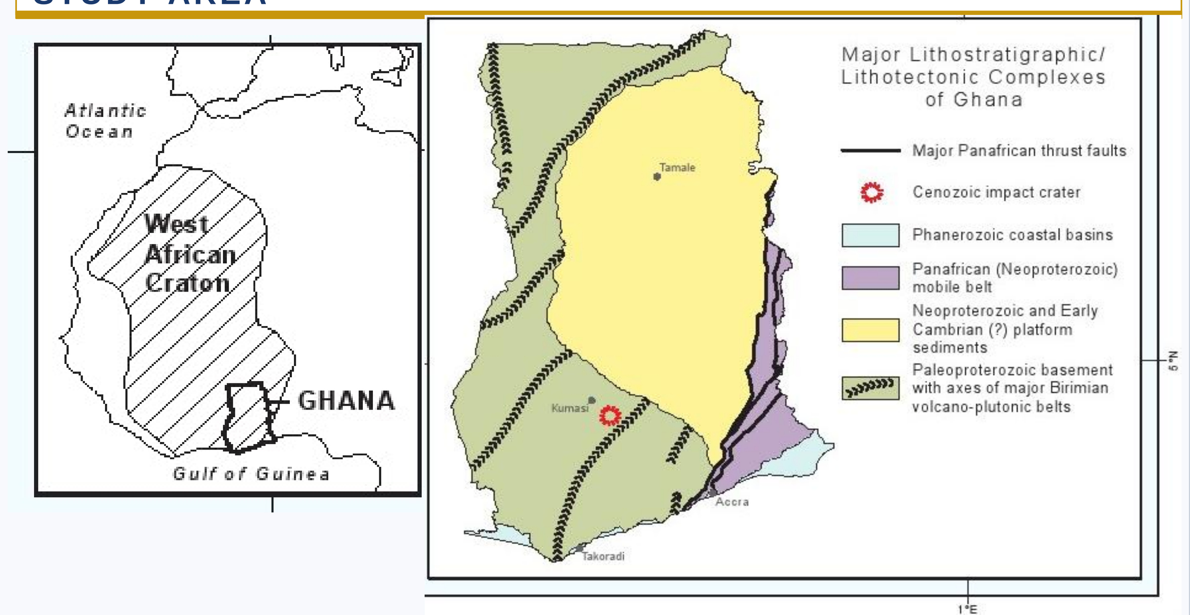


*Fig. 1:. Location of Ghana relative to the West African Craton and Pan-African Mobile Belt. The southeastern sector lies within the mobile belt — the primary locus of seismic activity.*

## METHODS

- Fault systems mapped from published geological & geophysical interpretations
- Offshore fracture zone extensions traced from bathymetric & seismic reflection data
- Historical catalogue: GGSD records 1615–2003 (Amponsah et al., 2009)
- Instrumental catalogue: broadband digital seismic network 2013–2023
- Epicentre plotting, focal mechanism review, depth distribution analysis

## FIELD OBSERVATIONS

*Fig. 4: Weathered, jointed basement outcrop within the study corridor, showing intense fracturing consistent with reactivated Precambrian shear zones.*

*Fig. 5: Field verification along the study corridor, recording structural and lithological observations used to ground-truth the mapped fault traces.*

## TECTONIC FRAMEWORK

**Stress Transmission Mechanism**

Mid-Atlantic Ridge (Ridge-Push) → Romanche & St. Paul Fracture Zones → WAC Southern Margin / Pan-African Belt → Reactivated Onshore Faults

- Akwapim Fault Range — major NE–SW structure; primary seismogenic source
- Coastal Boundary Fault — E–W system along the coastline; secondary source
- Ancient Precambrian shear zones periodically reactivated under present-day compressional stresses
- Seismicity aligns with NE–SW and E–W fault zones from reworked shear zones

**Tectonic Structural Map of Southern Ghana**

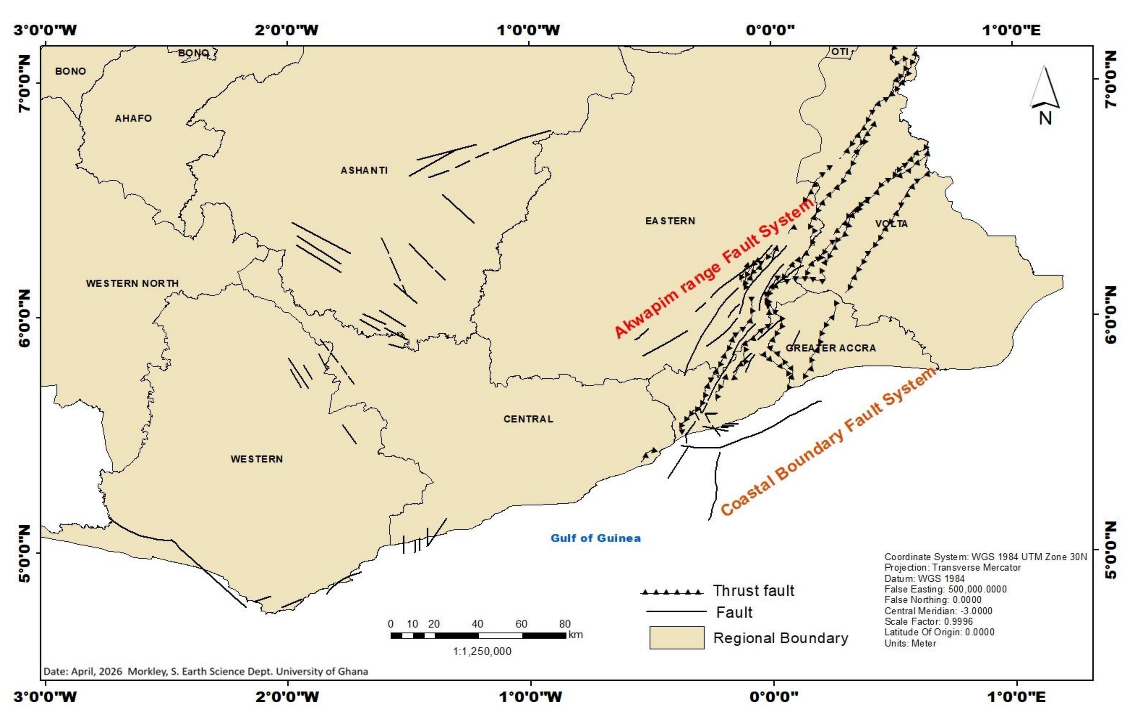


*Fig. 2: The Pan-African (Neoproterozoic) mobile belt in southeastern Ghana is the primary locus of seismic activity, in contrast to the stable WAC interior.*

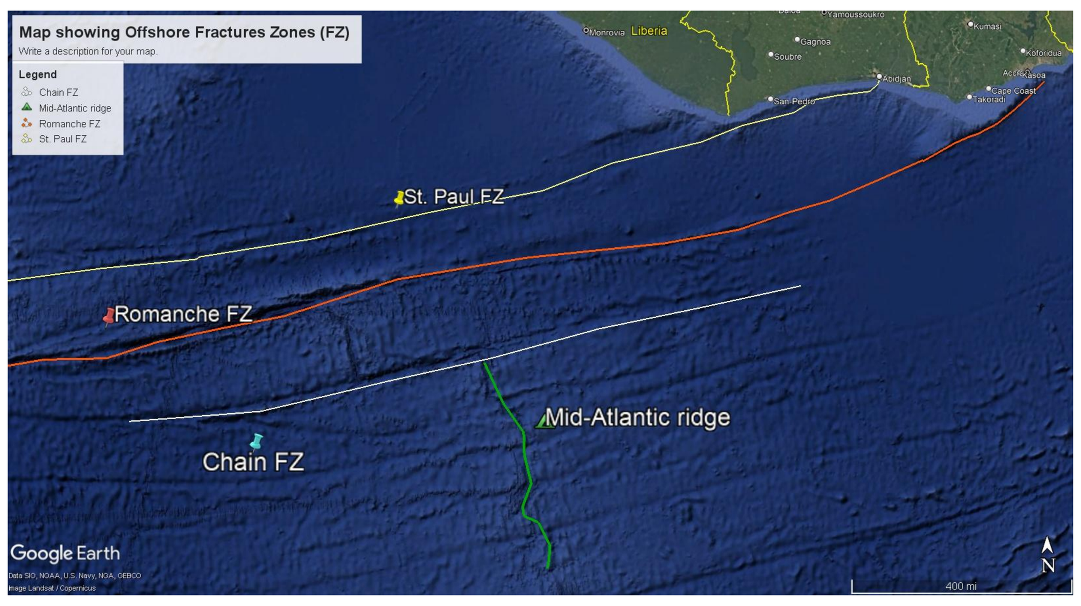


*Fig. 3: Coastal boundary fault system as an extension of the offshore fracture zones influencing seismic activity offshore the coast of Ghana.*

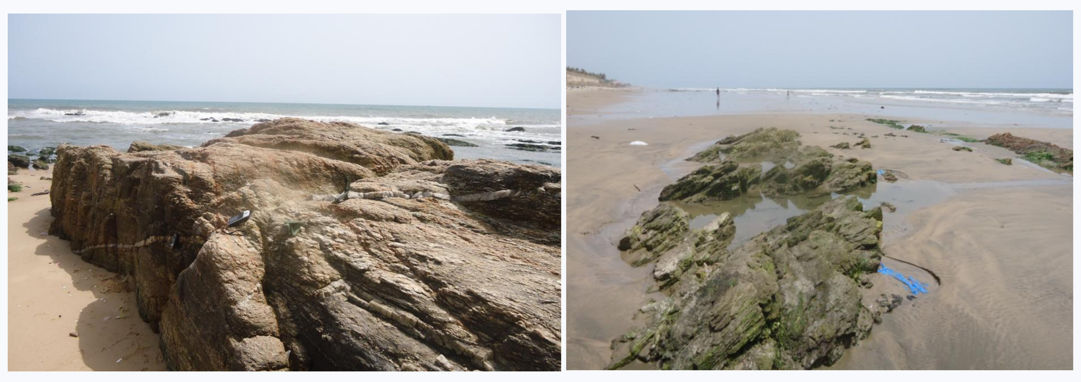

*Fig. 6: field observations at Nyanyano showing exposure along the coastline and offshore*

*Fig. 7: Togo structural units of the Pan-African mobile belt extension at Weija, Accra, where it converges with the Coastal boundary fault, recording high seismicity in the area.*

## HISTORICAL & RECENT SEISMICITY

- **1615 — First Documented Event** — The earliest earthquake in Ghana's written record
- **1862 — Major Damaging Event** — Significant structural damage recorded
- **1939 — Accra Earthquake — Ml 6.5** — Deadliest event; shallow strike-slip fault; major destruction and loss of life
- **1997 — Ml 4.8 Event** — Aligned with Akwapim–Coastal Boundary Fault intersection
- **2022 — Ve-Dafor — Ml 3.7** — Recorded by digital broadband seismic network; epicentre on known fault zone

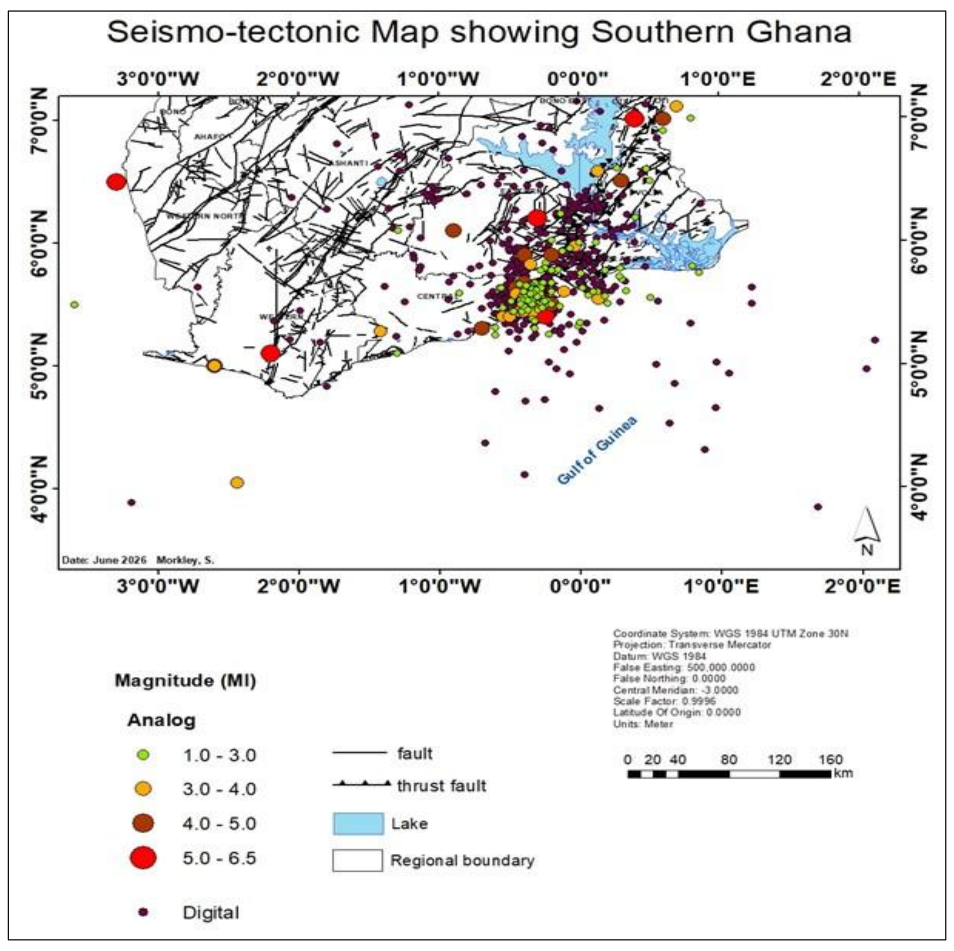


*Fig. 8: Spatial distribution of seismic epicenters delineating the Akwapim range and Coastal boundary fault systems with high seismic clustering at the convergence of these two fault systems.*

## KEY QUANTITATIVE RESULTS

- **6.5** ML — Largest event (Accra, 1939)
- 10% in 50yrs PoE — **0.1–0.2** g (PGA) — PSHA value for Accra
- **< 20** Depth (km) — Seismic events
- **408** years — Seismic record span 1615–2023

**Moderate–Significant Risk**

PGA 0.1–0.2 g with 10% probability of exceedance in 50 years (Ahulu et al., 2018). Urban expansion along fault corridors amplifies vulnerability in Accra–Tema.
Events with depths < 20km imply shallow earthquakes, which impact surface structures, e.g., buildings.

## SPATIAL ANALYSIS FINDINGS

- **Epicentre clusters at Akwapim Range – Coastal Boundary Fault intersection (Accra, Weija, Gbawe)**
- **Focal mechanisms confirm shallow intraplate characteristics**
- **Depth distribution supports crustal-scale fault reactivation — not deep-mantle activity**
- **1939, 1997 and 2022 events spatially aligned with mapped fault zones — confirming structural control**
- **Stable WAC interior contrasts sharply with reactivated margin zones**

## CHALLENGES

- **Urban Exposure: rapid growth, e.g. Accra, increases population density in high-risk corridors**
- **Monitoring Gap: sparse seismic network limits fault mapping and hazard forecasting accuracy**
- **Building Codes: current standards inadequate relative to actual tectonic threat**
- **Offshore Blind Spot: no ocean-bottom seismometers to track Atlantic stress transmission**

## CONCLUSIONS

Southern Ghana's seismicity is **structurally controlled** by fault reactivation along the southern WAC margin.

The **Romanche Fracture Zone** plays a pivotal role transmitting Mid-Atlantic Ridge stress inland, triggering earthquakes along Precambrian weaknesses.

The contrast between the **stable WAC interior** and **reactivated fault zones near Accra** is critical for hazard zoning, urban planning, and geophysical modelling.

A **multidisciplinary approach** integrating structural geology, geophysics, seismology, and urban planning is essential for resilience in Ghana's coastal cities.

## THE WAY FORWARD

**01 — Expand Seismic Network**
Broadband + ocean-bottom seismometers; GPS deformation monitoring

**02 — Microzonation Mapping**
Detailed maps for Accra, Tema, coastal areas; integrate fault zones

**03 — Revise Building Codes**
Seismic design for schools, hospitals, high-rise buildings

**04 — Community Preparedness**
Earthquake drills, school curricula, hazard awareness campaigns

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