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Earth Sciences Working Group

Cairo, Egypt

Bjorn von der Heyden

December 2024

Introduction and motivation

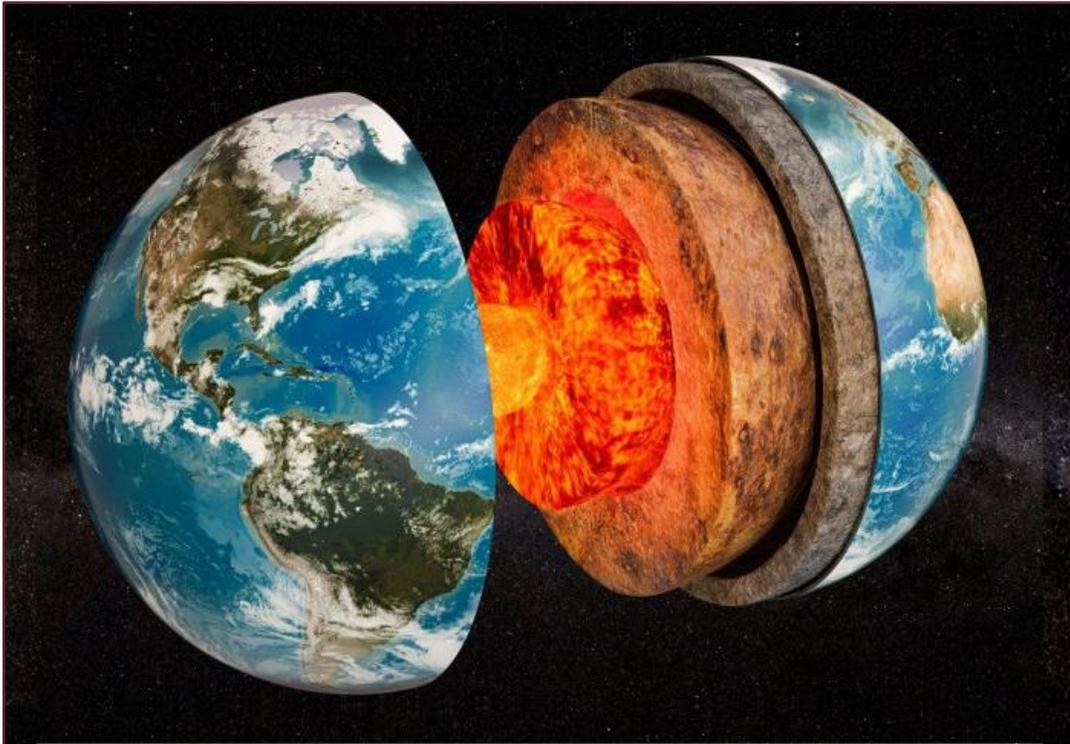


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Earth is a complex and multi-component system. Full understanding of all its inter-relationships requires application of physical, chemical and biological processes. Together these are understood as the earth sciences, which includes multiple subdisciplines including:

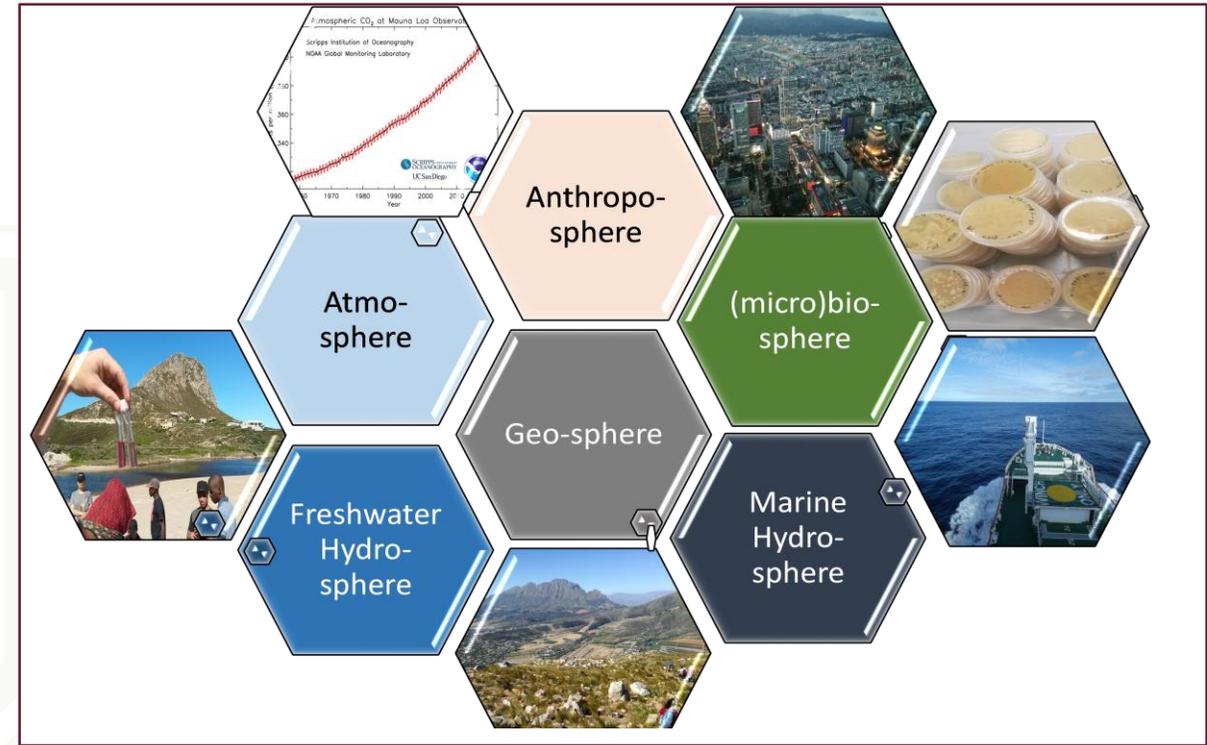


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Geology, Mineralogy, Petrology, Geophysics, Geochemistry, Seismology, Volcanology, Hydrology, Oceanography, Atmospheric Science, Palaeontology, Stratigraphy, Tectonics, Geomorphology, Environmental Science, Climatology, Glaciology, Soil Science, Hydrogeology, Geodesy, Planetary Geology

Introduction and motivation

- **Challenge 1:** Earth Science is inherently interdisciplinary, thus, earth scientists might not identify as physicists.
- Specific disciplines that relate strongly to physics include: **hydrogeology, geophysics, geophysical fluid dynamics, atmospheric physics and aeronomy, ocean physics, space physics and astronomy, environmental physics, meteorology, climatology, tectonics, seismology, gravity and magnetism, mineralogy and petrology, geochronology, ecotoxicology, among others.**
- Additionally, almost all sub-disciplines of the earth sciences rely on measurements of physical properties to characterize and understand observed phenomena e.g.:
 - X-ray diffraction for mineralogy (interactions between X-rays and matter),
 - optical microscopy for petrography (interactions between visible light and matter),
 - chemical mapping (scanning electron microscopes, interactions between electrons and matter).
- **Recommendation 1:** Clearly define the nexus between earth sciences and physics, this will make the working group resonate more strongly with the community.

Introduction and motivation

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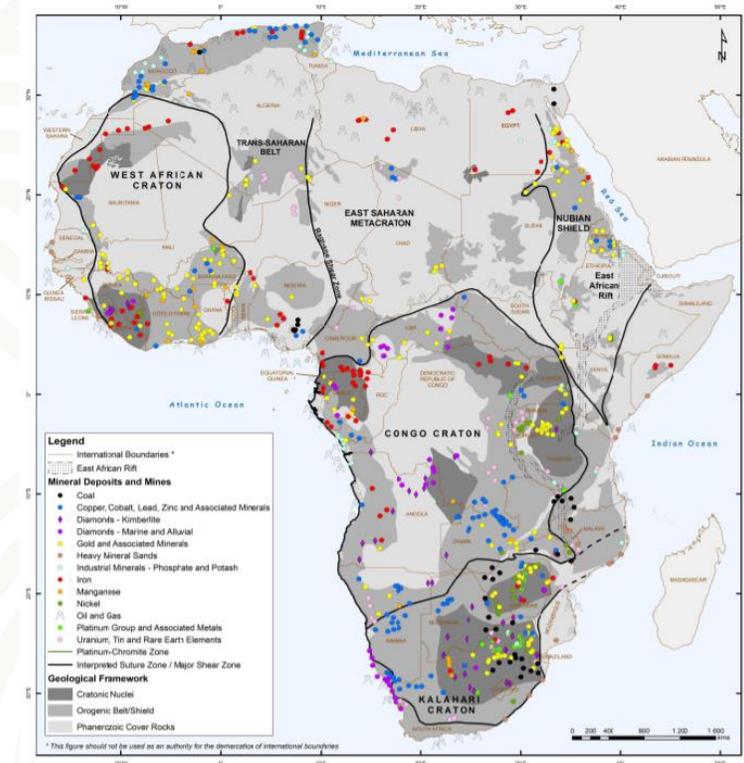
ChatGPT answer: “The nexus between physics and earth sciences is centred on using physical principles to explain, model, and predict natural phenomena that shape the Earth. Geophysics, seismology, thermodynamics, fluid dynamics, and electromagnetism are just some of the areas where physics directly contributes to our understanding of Earth processes. By applying laws of motion, energy transfer, and material properties, physicists and Earth scientists work together to uncover the mysteries of the Earth's past, present, and future.”

- Noteworthy comment for inclusion: no mention of earth physics in e.g., CERN Strategy, Snowflake, LASF4RI.
- There are however strategy documents which include: The African Union (AU) Science, Technology and Innovation Strategy for Africa (STISA-2024), the African Ministerial Conference on the Environment (AMCEN), The African Geological Congress (AGC) Strategy; The Global Earth Observation System of Systems (GEOSS) African Strategy; The African Water Vision 2025; The African Network of Earth Observations (AFRO EOS); The African Development Bank (AfDB) Strategy; The Africa Climate Change Strategy

Introduction and motivation

- Possible addition towards strengthening the motivation (*also to build into small subsections later in the chapter; also links to general ASFAP introduction*):
- Highlight key case studies/topics that will attract the attention of funders and national governments:

- **Climate change:** Physical oceanography and meteorology
- **Critical earth resources:** exploration for new resources (geophysics, and geology), safety in mining (rock mechanics, geotechnical engineering), more efficient beneficiation (mineralogy, comminution science)
- **Water security:** hydrogeology
- **Pollution dispersion:** meteorology (dust migration), hydrogeology (water pollution)
- **Food security:** Soil geochemistry from hyperspectral data
- **Geothermal energy:** geology, geohydrology
- **Seismic and volcanic risks:** seismology, geophysics, volcanology



Frost-Killian et al. (2016)

- Shall I include connections to SDG? Then this should be consistent across chapters.

Working group activities

- Ongoing scientific and strategy related interactions with the broader ASFAP community (Haddad et al. 2022),
- ~~A planned mini-symposium to coincide with International Earth Week 2021 (ultimately postponed to avoid a clash in dates with the African Geophysical Society),~~
- Development of a mailing list comprising twenty-three email addresses of individuals who are passionate about the future of earth sciences on the African continent,
- Successful presentation of the Earth Sciences working group achievements at a major regional earth sciences conference (Geocongress 2023 (11-13 January 2023; Stellenbosch, South Africa)),
- **Successful design and distribution of a targeted survey investigating the perceived future needs of the African earth sciences community (see 11.4).**

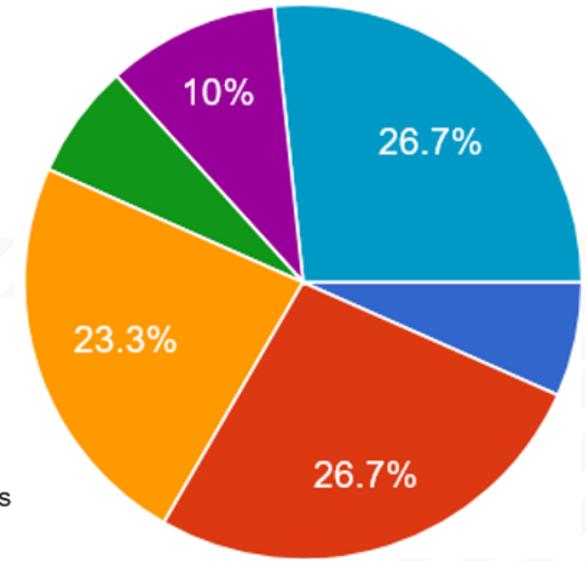
Earth Sciences working group survey

- Primary means of data collection. Established after no Earth Science-related LOI were received during the initial 'call for LOI'.
- Both survey and initial LOI call were disseminated using ASFAP community, personal contacts, national level societies.
- Four questions to obtain metadata on the respondents.
- Four questions seeking to elucidate the main issues impacting the African earth sciences:
 - *Please detail any barriers (e.g., access to students, funding, analytical equipment, researcher support, etc.) that currently hinder your abilities to conduct earth science research on or for the African continent?*
 - *If you were awarded US\$ 1000 towards advancing the physics-related needs or future goals of the earth sciences, kindly explain how you would best spend it?*
 - *If you were awarded US\$ 1 million towards advancing the physics-related needs or future goals of the earth sciences, kindly explain how you would best spend it?*
 - *Please leave any other remarks which may serve to advise future physics strategy development for advancing the status of earth sciences on or for the African continent.*
- Data evaluated in a qualitative manner using social science study techniques.

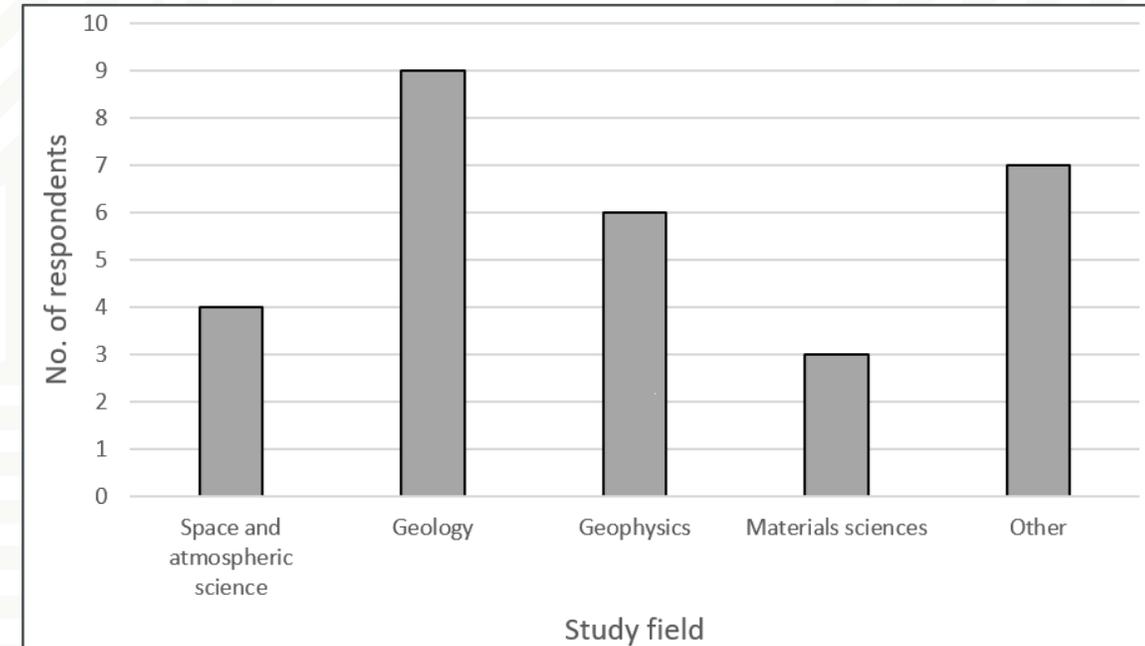
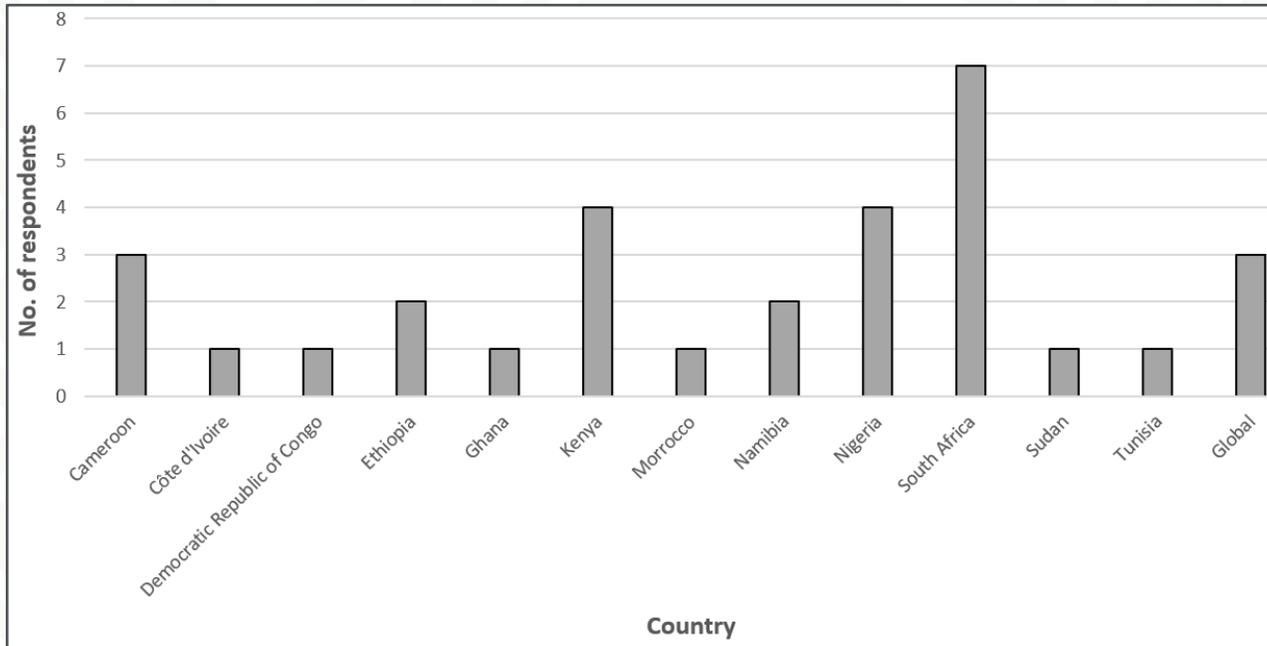
Earth Sciences working group survey

- Demographics:

Over thirty respondents completed the survey, with respondents comprising a broad array of nationalities including ~30% of respondents each from west Africa and southern Africa, 20% from east Africa, and ~10% each from north African and other countries outside of Africa



- Current undergraduate student
- Current postgraduate student
- 0-5 years experience post studies
- 5-10 years experience post studies
- 10-20 years experience post studies
- >20 years experience post studies



High priority future needs

- Needs requiring high degrees of financial support (e.g., \$1 million)
 - Requests for analytical equipment received from respondents across all demographic groups:
 - E.g., road-band and short period seismic equipment; a flume for fluid dynamics research; multiple meteorological mini-weather stations; among others.
 - Subset of the funding needs to be set aside for technical staff training, for operating expenses and for funding of associated student projects.
 - Two models: centralised facility at a stable research facility vs. smaller labs distributed across a greater geographic area.
 - Alternative suggestion is to be split into smaller tranches for utilization towards enhancing student and researcher training (*bursaries for undergraduate and post-graduate students, overseas visits and conference/workshop attendance for researchers, and towards attracting international post-doctoral research fellows to African laboratories*)

High priority future needs

- Needs requiring low degrees of financial support (e.g., \$1000):
 - Smaller equipment purchases
 - Upgrade/repair of existing equipment (concerning implication that equipment is in disrepair)
 - Bursaries awarded on merit/competitive basis
 - Other uses: field trips, workshops, publication costs, scientific communication
- Other suggestions arising:
 - Promote increased collaboration: across border data sharing, enabling government policies, increased funding opportunities, increased industry-academia collaboration.
 - Sustained talent pipeline: outreach programs, geoscience education initiatives, merit-based bursary programs, practical training opportunities,
 - Grant writing skills, use topical issues (climate, food/water security, resources) as a ‘hook’

Conclusions/recommendations

- Perceived dearth of funding
 - More funding opportunities requested from funders
 - African earth scientists must be better trained in grant writing
- Limited access to high end facilities
 - Start point will be to collate list of equipment available on the African continent (list of RSA labs (compiled by A. Hofmann; ChatGPT with proofing)).
 - Increase the number of institutional/national research agreements between African entities.
- Current list of recommendations are achievable. Lack of strong/tangible recommendations for targeted scientific investigation.

Possible further work

- Current document is concise and has nice flow.
- Add acknowledgements (co-convenors who fell off, contributors to survey)
- Aspects not emerging from the survey: indigenous knowledge systems, AI and big data skills, Outreach and education only briefly alluded to, **I'm sure there are others...**
- Possible improvements: alignment with SDG, case studies of 'topical issues', critical comparison with other existing strategies, review by existing mailing list, review by broader community on e.g., LinkedIn. – **please advise**
- Linkages with other working groups:
 - Executive summary highlights Africa resources as a 'hook'
 - Mentions 3.2.2 (CERD); 3.7; 3.4 (all accelerators); 7 (computing); 11 (instrumentation); 12 (light sources); 13 (materials for chips come from Africa); 17 (PAUL need for geophysics); 18.1 (resources to beat poverty); 18.4 (physics and environmental pollution).



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Thank you...

...Questions