Earth sciences at an African Light Source

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Synchrotron studies provide many unique and highly specialized insights into earth science samples, which we study to better understand how the earth system formed and how minerals and geochemical solutes interact within broader biogeochemical cycles. Importantly, Africa is endowed with some of the world's greatest geological features and mineral deposits (e.g., Witwatersrand goldfield, Bushveld Igneous Complex, Great Dyke, among others), and it contains an array of endemic flora and fauna which thrive within discrete and often sensitive terrestrial and marine habitats. Given the current strong drive towards developing an African Light Source (AfLS), it is crucial that the important and extensive field of Earth Sciences is well represented during the planning and conceptualization phases of the AfLS initiative. To provide a baseline from which to support this representation, the current study critically reviews over thirty previous research papers in which synchrotrons were used to study earth science samples derived from Africa (Fig. 1). These studies include work that evaluates the chemistry and internal conditions of the earth's mantle (from kimberlite materials), studies of the trace elements and coordination chemistry associated with several important ore deposits (including gold, chromite, pegmatites, rare earth elements in carbonatites, manganese, Pt-Cu-Ni and other base metal mineralisation), and work that looks at the coordination chemistry of both deleterious and beneficial trace elements in soils, aquatic colloids and aerosols (Fig. 1).

Based on this review, we have suggest that the most crucial synchrotron needs of the African earth science community include a dedicated synchrotron X-ray Fluorescence Mapping (XFM) beamline capable of collecting large datasets through a multi-detector array; a hard X-ray spectroscopy beamline which is capable accessing the X-ray absorption edges of heavy ore metals; and a soft X-ray beamline that can be used to evaluate the light and bioactive elements such as C, N, S, etc. A proportion of the presentation will further be utilized towards informing the research community of various initiatives which are underway to promote the earth sciences at synchrotrons. These include inputs into a section of the African Light Source conceptual design report and a current call for letters of interest for the African Strategy for Fundamental and Applied Physics.

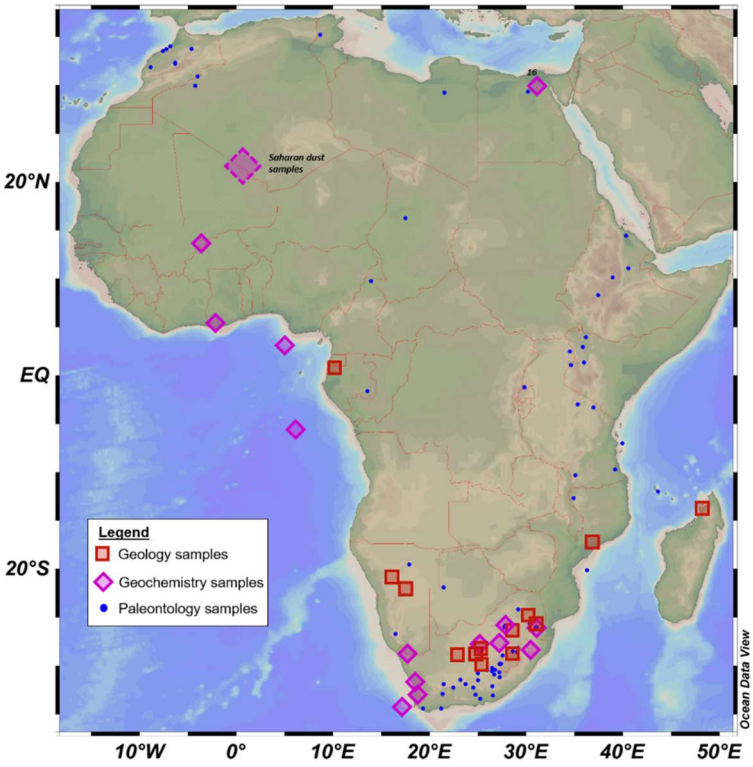

Fig. 1: Distribution of earth science samples that have been studied at synchrotrons globally (adapted from von der Heyden et al. 2020).

References

[1] von der Heyden, B.P., Benoit, J., Fernandez, V. and Roychoudhury, A.N., 2020. Synchrotron X-ray radiation and the African earth sciences: A critical review. Journal of African Earth Sciences, 172, p.104012.