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Synchrotron science applied to the Earth Sciences

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Recent advancements in synchrotron technology have resulted in the advent of an era in which ultra-high brilliance "Fourth Generation" synchrotron light sources promise to contribute significantly to high-level scientific research. These X-rays provide tuneable, high energy, and high brilliance X-rays that can measure sub-ppm elemental concentrations on spatial scales approaching 10 nm. Despite these affordances, synchrotron X-rays are relatively under-utilised by researchers practicing in the broad field of the earth sciences and notably in the field of ore geology research.

This presentation serves to introduce the African geological and mineralogical communities to the unique application of synchrotron light to e.g., coordination chemistry in fluids at geologically relevant P-T conditions; fluid inclusion analyses; distribution, crystallographic siting and redox speciation of trace elements within ore mineral parageneses; and characterisation of poorly crystalline and sub-micrometer scale mineral precipitates. An overview of the different, pertinent synchrotron X-ray analytical techniques will be provided and the technological specifications of commonly utilised synchrotron X-ray beam-lines will be explained. A number of case studies will be discussed focusing on the use of synchrotron X-rays to investigate important research questions related to mineralisation of precious metals (gold), base metals (zinc) and bulk commodities (Mn).

Finally, the presentation will highlight perceived future directions for the application of synchrotron light to ore-related research. The implications of this review will be discussed in a context of its relevance to African mineralogical and geological research, with special emphasis given to the prospect of the African Light Source (AflS; a proposed/conceptualised synchrotron facility on the African continent).

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