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# Synchrotron light applied to ore geology

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Scientific research studies focussed on ore deposits have traditionally applied conventional techniques such as optical microscopy and scanning electron microscopy (coupled with microprobe) to understand the nature and geology of the mineralising systems. However, the emergence of synchrotron radiation facilities and the rampant advancements in the field of synchrotron science have enabled researchers to develop X-ray based techniques to investigate novel aspects of mineralised systems.

Synchrotron techniques, coupled with the development of high pressure and temperature cells, have been widely applied to speciation and coordination chemistry studies of model hydrothermal systems. Such molecular level information has been useful in explaining the thermodynamic behaviour and solubility of economically-important elements in hydrothermal fluid and gas media. Spectroscopic techniques (notably X-ray Absorption Near Edge Structure (XANES) and Extended X-ray Absorption Fine Structure (EXAFS)) have further found application in understanding the crystallographic siting and redox speciation of trace elements (e.g., Rare Earth Elements) in the host minerals; and synchrotron-based high-resolution X-ray diffraction is routinely used to characterise new mineral phases (e.g., uranium-bearing štěpite [1]). Synchrotron X-ray Fluorescence (XRF) allows insight into chemical composition of fluid inclusions and can be coupled with spectroscopic techniques to provide insights into the chemical speciation of included fluids and minerals. The behaviour of metals and trace elements released into the low temperature geochemical environment through mining and ore extraction practices is also a field that is actively being explored with synchrotron light. This is because these phases are commonly present only in the micron to sub-micron size fraction, and small X-ray spot sizes are needed to understand their speciation and chemical interactions in order to comment on their mobility. Examples of these and other uses of synchrotron light for ore geology studies will be discussed, and a summary of available techniques and beamline facilities will be critically reviewed.

In light of the exceptionally high spectral- and spatial resolutions expected for the ultra-high brightness storage ring technologies currently being developed (pun intended); this review represents a comprehensive and timely overview of techniques that will find increasing importance in studies focussed on understanding the broad field of economic geology.

[1] Plasil J et al. (2013) Mineral Mag 77:137-152