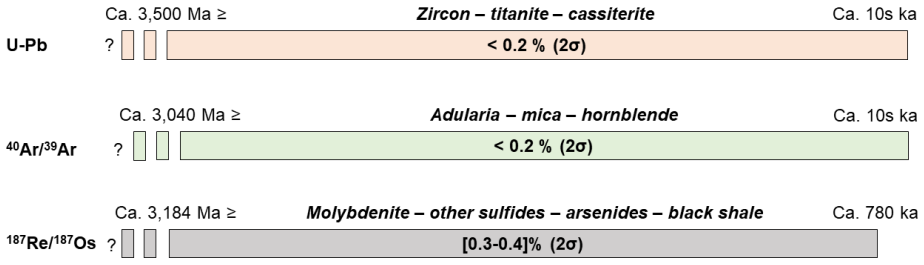
SC8: Geochronology applied to mineral deposits (U-Pb, Ar-Ar, Re-Os)

Cyril Chelle-Michou (ETHZ), Richard Spikings (UNIGE) & Nicolas Saintilan (ETHZ)

Post-conference short course 02-03 September 2023, ETH Zürich



An accurate and precise temporal framework and duration of ore-forming events is instrumental to place mineralizing processes within a geodynamic context and to the development of genetic models necessary to explore mineral deposits. This course is designed to provide a detailed overview of the most robust isotopic systems commonly used for absolute dating of mineral systems (U-Pb, 40Ar/39Ar, Re-Os), which can yield internal precisions on the mineralisation age of <0.2 % (2σ) for U-Pb and 40Ar/39Ar, and [0.3-0.4]% for Re-Os. The course will be structured in three modules that will cover key theoretical and practical aspects of all three isotopic systems.

The U-Pb module will initially focus on the basics of the U-Pb systems, with its intrinsic limitations and pitfalls, and the statistical treatment of U-Pb dates. Then we will discuss the different analytical methods used for U-Pb geochronology with their respective advantages and limitations with emphasis on aligning the required level of precision and accuracy to the type of scientific question that is aimed to be answered. We will review the wide range of mineral amenable to U-Pb geochronology in the context of mineral deposits and how they could be used in practice for the study of mineral deposits. This module will be illustrated with several case studies from ore deposit research to highlight the ever-increasing potential of this isotopic system.

The 40Ar/39Ar module will start with a brief discussion on precision (relative and absolute) and accuracy, and how these should be considered when dating ore deposits. The basics of the 40Ar/39Ar method will be explained (e.g. step-heating versus in-situ UV ablation), with a brief discussion on closed and open system behaviour. Many case studies will be presented that demonstrate i) the applicability of specific minerals to 40Ar/39Ar geochronology (e.g. alunite), ii) potential pitfalls that can arise with some minerals (e.g. excess 40Ar and sericite), and iii) combining different techniques, such as the 40Ar/39Ar, fission track and (U-Th)/He methods, to construct temporal frameworks for mineralisation and subsequent burial, exhumation and fault displacement, which has implications for ore deposit preservation

In the Re-Os module, we will describe the chemical properties of Re and Os that make sulphides be amenable to absolute geochronology using the 187Re-187Os radiogenic system. Then, the requirements in terms of sampling and production of pure monophasic mineral separates will be discussed. The difference between “isochron ages” and “model ages” will be reviewed as well as their respective implication in terms of technical requirement and tracer solution. Then, we will (1) explain the subtleties of Re-Os isotope geochemistry protocols, (2) highlight the paramount technical development of negative thermal ionization mass spectrometry for accurate and high-precision Re-Os geochronology to exist, and (3) discuss the meaning of the initial 187Os/188Os ratio of common Os in an isochron regression and how it can be used to trace the source of metals. Specific case studies of molybdenite geochronology in porphyry systems, bornite geochronology in epigenetic sedimentary rock-hosted deposits, and cobalt arsenide geochronology will be presented with the intended aim to lead a lively discussion and question time.

SC8: Geochronology applied to mineral deposits (U-Pb, Ar-Ar, Re-Os)

Cyril Chelle-Michou (ETHZ), Richard Spikings (UNIGE) & Nicolas Saintilan (ETHZ)

Post-conference short course 02-03 September 2023, ETH Zürich

Cyril Chelle-Michou is Professor of Mineral Resource Systems at ETH Zurich, Switzerland. He received his PhD from the University of Geneva. He is mainly interested in quantifying the geological processes that modulate the size of magmatic-hydrothermal and sediment-hosted hydrothermal deposits and in developing new exploration methods and decision tools to help targeting the biggest orebodies as early as possible. He heads the high-precision U-Pb geochronology laboratory of ETHZ and develops new methods to broaden the applications of the U-Pb system across mineral systems.

Richard Spikings is faculty at the Department of Earth Sciences, University of Geneva, Switzerland. His research in thermochronology earned a PhD in geology in 1998 from La Trobe University, Melbourne. He subsequently worked as a postdoctoral fellow at the ETH-Zurich, and as tenured faculty at the University of Geneva where he currently manages the noble gas mass spectrometry laboratory. His research has focussed on the thermochronology and geochronology of active margins and cratonic interiors. More recently, Richard has focussed his research efforts on bulk and in-situ U-Pb and 40Ar/39Ar thermochronology.

Nicolas (Nic) J. Saintilan is a Senior Researcher at ETH Zürich (CH) and past recipient of an Ambizione Fellowship (2019–2023) of the Swiss National Science Foundation (SNSF). He manages the Re-Os geochronology laboratory that he established from scratch between February 2019 and March 2020. After 4.5 years working in mineral exploration, Nic started his academic career in 2011. He holds a PhD (2015) from the University of Geneva (CH). During successive postdoc positions as recipient of SNSF Postdoc mobility grants (2015–2018), Nic was trained by Rob Creaser (University of Alberta, Canada) and Dave Selby (Durham University, UK) in two of the foremost world-class Re-Os laboratories in the world. Nic is a rising specialist in sulfide Re-Os isotope geochemistry and pioneered Re-Os geochronology of Co-Cu-sulfides, sulfarsenides and arsenides. Nic is involved in many collaborative research projects in which sulfide Re-Os geochronology is critical for the mining industry and other academic colleagues. Nic has authored 17 publications, 14 of which as first author since 2015.