

Lecture Abstract:

U-series dating of speleothems

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U-series dating is commonly used to derive chronological information about speleothem growth and thus important for almost any speleothem based palaeoclimate study. This lecture intends to provide an overview on basics of U-series dating and techniques to measure U-series ratios for speleothem applications. The focus will be on U-Th dating and on practical questions for speleothem chronologies. Following topics will be addressed:

- Theory and principles of U-series dating
- Applicability and constraints of U-series dating
- Methods to measure U-series isotope ratios for dating
- Precision and accuracy of U-series dating
- High spatial resolution dating (small sample sizes)
- High precision dating (large sample sizes)
- Strategies for U-series dating of speleothems including questions such as where and how to take sub-samples, what sample sizes are needed, how many dating points are needed.
- Detrital corrections, isochron techniques
- In brief U-Pa and U-Pb techniques

Suggested literature

1) Overview articles:

- Richards and Dorale (2003) Uranium-series chronology and environmental applications of speleothems. In: Bourdon, Henderson, Lundstrom, Turner (Eds.), Uranium-series Geochemistry. Mineralogical Society of America, Washington, DC, pp 407-460.
- Dorale et al. (2007) Uranium-series dating of speleothems. In: Sasowsky and Mylroie (Eds.) Studies of Cave Sediments, Springer, pp 177-197

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- Scholz and Hoffmann (2008) $^{230}\text{Th}/\text{U}$ -dating of fossil reef corals and speleothems. Quaternary Science Journal (Eiszeitalter und Gegenwart), 57 (1-2): 52-77 (<http://quaternary-science.publiss.net/issues/57/articles/778>)

2) Selected specific articles:

- Hoffmann et al. (2009) Micromill and in situ laser ablation sampling techniques for high spatial resolution MC-ICPMS U-Th dating of carbonates. Chemical Geology, 259, 253-261 (small samples, high spatial resolution U-Th dating)
- Cheng et al (1998) Uranium-thorium-protactinium dating systematics. Geochimica et Cosmochimica Acta, 62, 3437–3452 (U-Th-Pa dating)
- Ludwig and Titterton (1994) Calculation of $^{230}\text{Th}/\text{U}$ isochrons, ages, and errors. Geochimica et Cosmochimica Acta, 58, 5031-5042 (detritus and isochron techniques)
- Woodhead et al. (2006) U–Pb geochronology of speleothems by MC-ICPMS. Quaternary Geochronology 1, 208–221 (U-Pb dating)
- Edwards et al. (1987) ^{238}U - ^{234}U - ^{230}Th - ^{232}Th systematics and the precise measurement of time over the past 500,000 years. Earth and Planetary Science Letters, 81, 175-192 (TIMS techniques and coral dating)
- Schwarcz (1989) Uranium series dating of Quaternary deposits. Quaternary International, 1, 7-17 (alpha counting and TIMS techniques)
- Hoffmann et al. (2007) Procedures for accurate U and Th isotope measurements by high precision MC-ICPMS. International Journal of Mass Spectrometry, 264, 97-109 (MC-ICPMS techniques)
- Shen et al. (2002) Uranium and thorium isotopic and concentration measurements by magnetic sector inductively coupled plasma mass spectrometry. Chemical Geology, 185, 165-178 (sector field ICPMS techniques)
- Douville et al. (2010) Rapid and accurate U–Th dating of ancient carbonates using inductively coupled plasma-quadrupole mass spectrometry. Chemical Geology, 272, 1-11; Hernández-Mendiola et al. (2011) U-series dating of carbonates using inductively coupled plasma-quadrupole mass spectrometry. Quaternary Geochronology, 6, 564-573 (quadrupole ICPMS techniques)

3) Further reading

- Ivanovich and Harmon (1992) Uranium-Series Disequilibrium. Clarendon Press Oxford, UK (classic literature on U-series but sold out)
- Bourdon, Henderson, Lundstrom, Turner (Eds.) (2003), Uranium-series Geochemistry. Mineralogical Society of America, Washington, DC