DEPARTMENT OF EARTH SCIENCES

Lithium isotopes tracing weathering processes in a time series through soil porewaters

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MOTIVATION

Silicate weathering is a major influence on Earth's carbon cycle but the **controls** on weathering are poorly quantified

- **How do temperature and precipitation control weathering?**

Lithium isotopes have been used to understand paleo-weathering processes on kyr and Myr **timescales**

- **Do weathering processes vary over much shorter timescales?**

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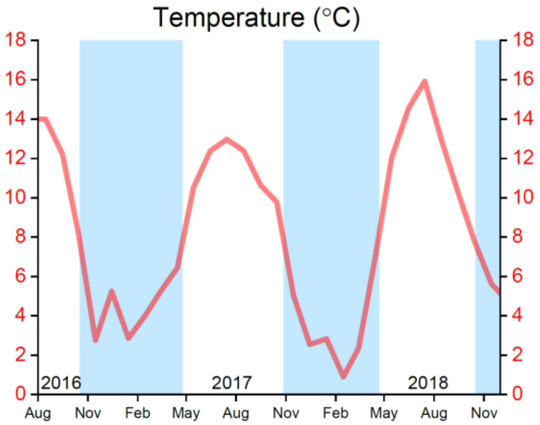
SETTING AND APPROACH

UCL

Cave drip-waters enable monitoring of soil porewaters in Yorkshire Dales, U.K.

Limestone bedrock covered by till and peaty soils

Drip-waters collected from multiple drip sites in two caves



Seasonal temperature changes of ~10 °C

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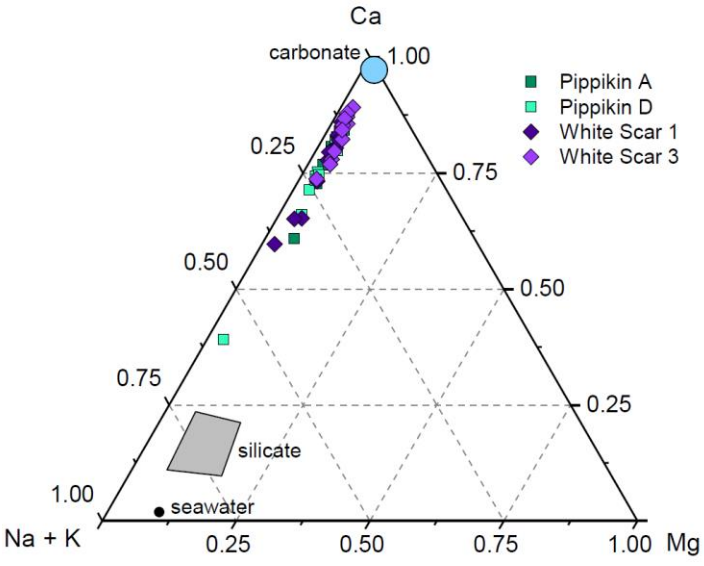
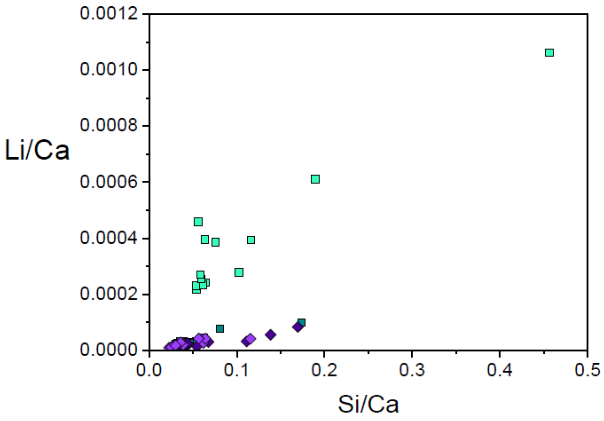
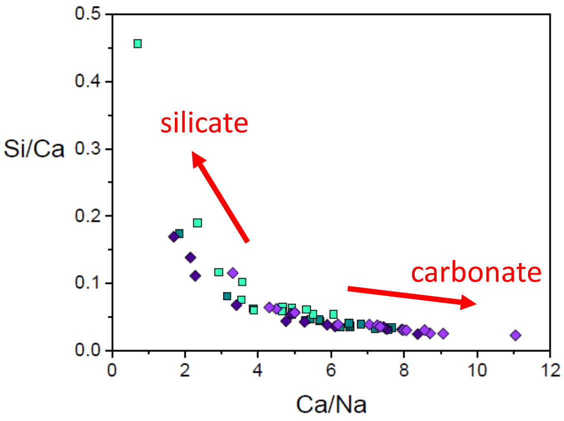
DRIP-WATER CHEMISTRY

- Cation chemistry dominantly reflects carbonate weathering
- Lithium budget is determined by silicate weathering







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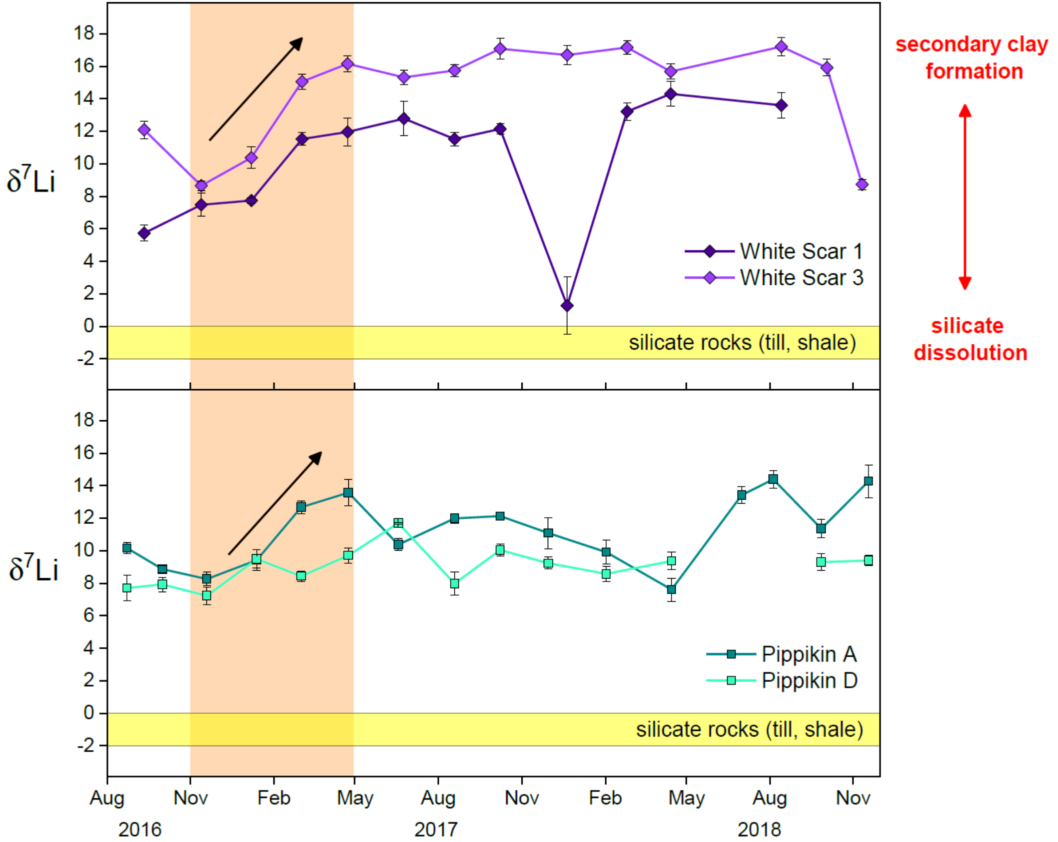
DRIP-WATER LITHIUM ISOTOPES



- Local silicate weathering sources (e.g. till, shale) have δ^7Li = -1±1 ‰ (yellow band)
- Drip-water δ^7Li is offset from weathering inputs due to secondary clay formation (which preferentially removes ^{6}Li)
- Coherent temporal shifts (e.g. orange bar) are larger than inter-site variability

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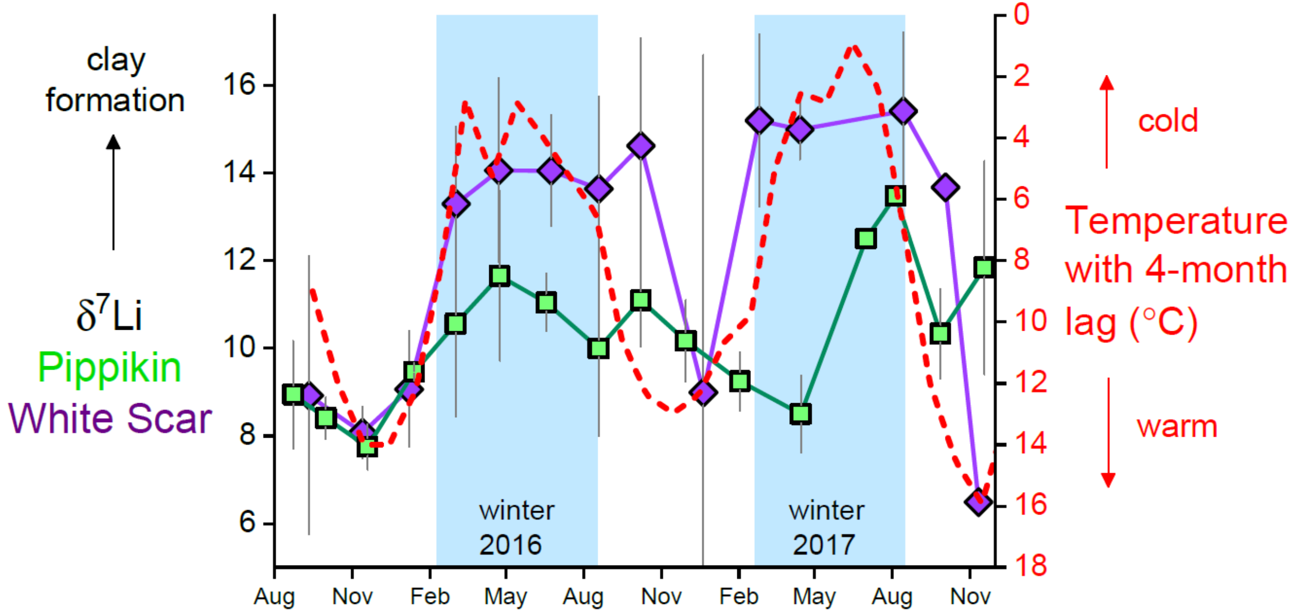
TEMPERATURE CONTROL ON WEATHERING

- Drip-water δ^{7}Li increases under cooling conditions, but with a lag of ~4 months behind surface air temperature



- Silicate weathering is less congruent (i.e. more clay formation) at lower temperatures, supporting recent observations from Israeli speleothems [Pogge von Strandmann et al., 2017, *EPSL*]

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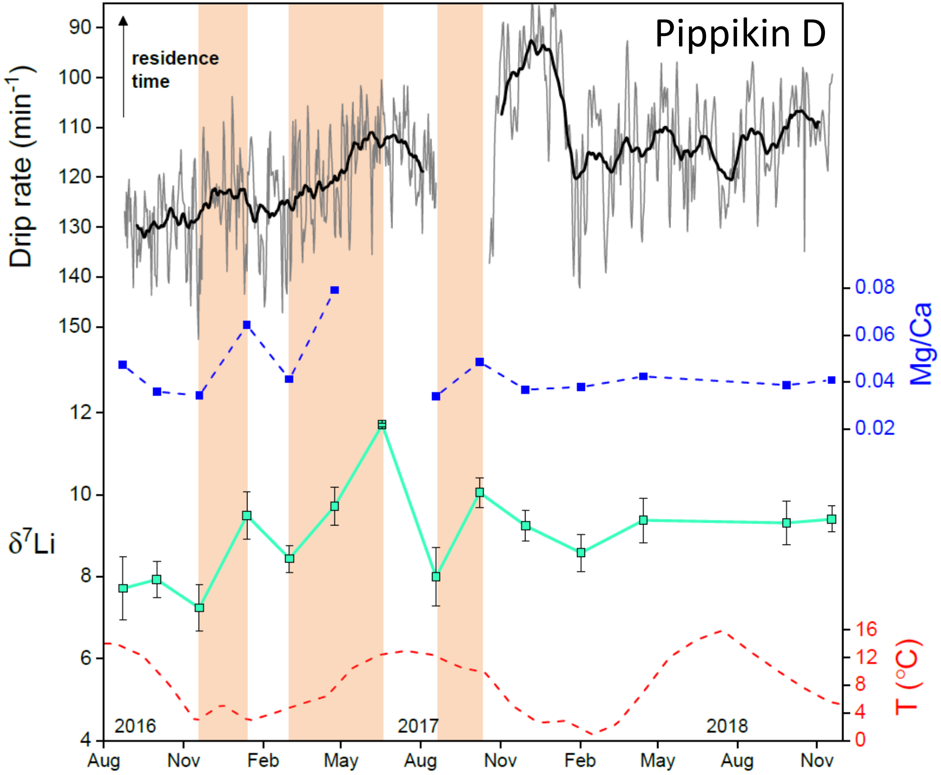
EFFECT OF FLUID RESIDENCE TIME



- ➢ Drip rates at Pippikin D suggest an additional control: longer fluid residence times lead to more clay formation and higher δ^7Li (orange bars)
- ➢ Soil porewater processes may be partly responsible for a proposed link between fluid residence times and riverine δ^7Li variations [e.g. Liu et al., 2015, *EPSL*; Manaka et al., 2017, *G3;* Hindshaw et al., 2019, *GCA*]

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SUMMARY

- Cave drip-waters provide an archive of soil porewater lithium isotopes, opening up the potential for high-resolution time series
- Lithium isotopes record rapid seasonal changes in weathering congruency (i.e. silicate dissolution vs. clay formation)
- Controls arise from temperature and fluid residence time
- Valuable ground-truthing for interpreting paleo-weathering records

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