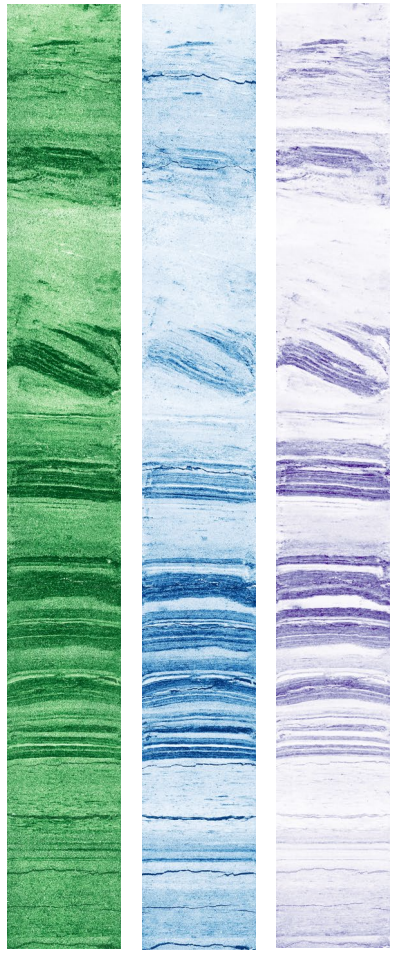
Tracking high-resolution variations of phototrophic communities during the Holocene using hyperspectral imaging core-scanning, Lake Cadagno, Swiss Alps

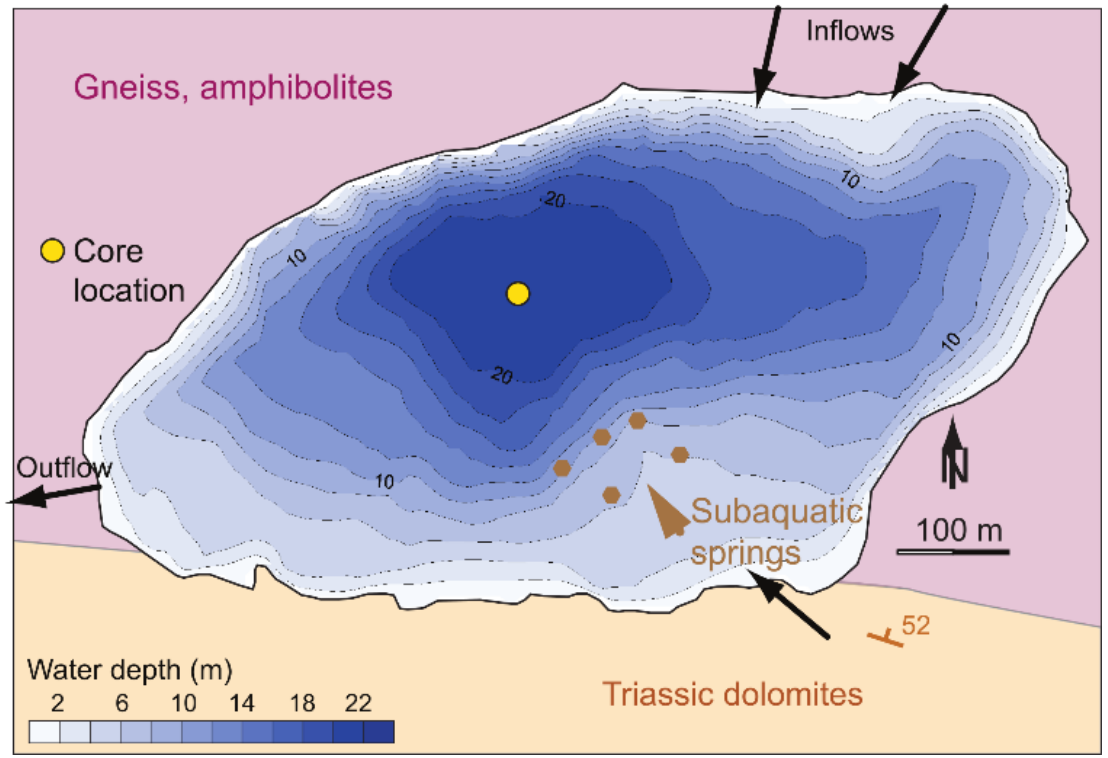
Paul D. Zander[1], Stefanie B. Wirth[2], Adrian Gilli[3], Martin Grosjean[1]

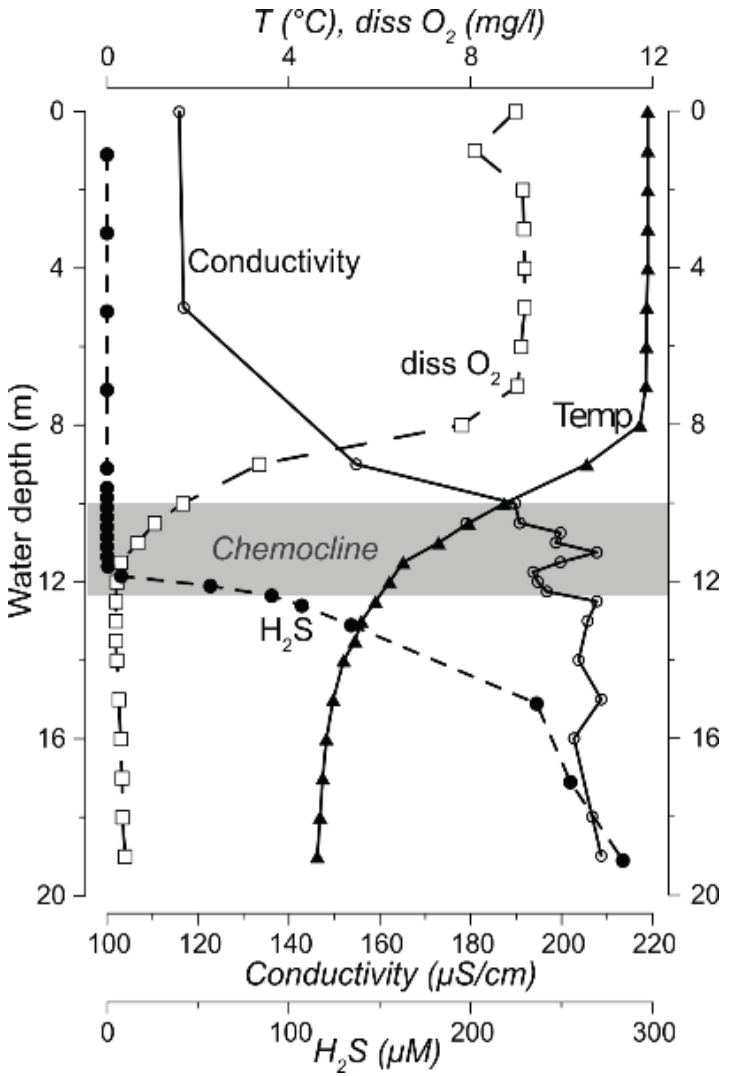
[1] Institute of Geography and Oeschger Centre for Climate Change Research, University of Bern, Bern, Switzerland
[2] Centre for Hydrogeology and Geothermics, University of Neuchâtel, Neuchâtel, Switzerland
[3] Geological Institute, ETH Zurich, Zurich, Switzerland



CC BY

Study site: Lake Cadagno





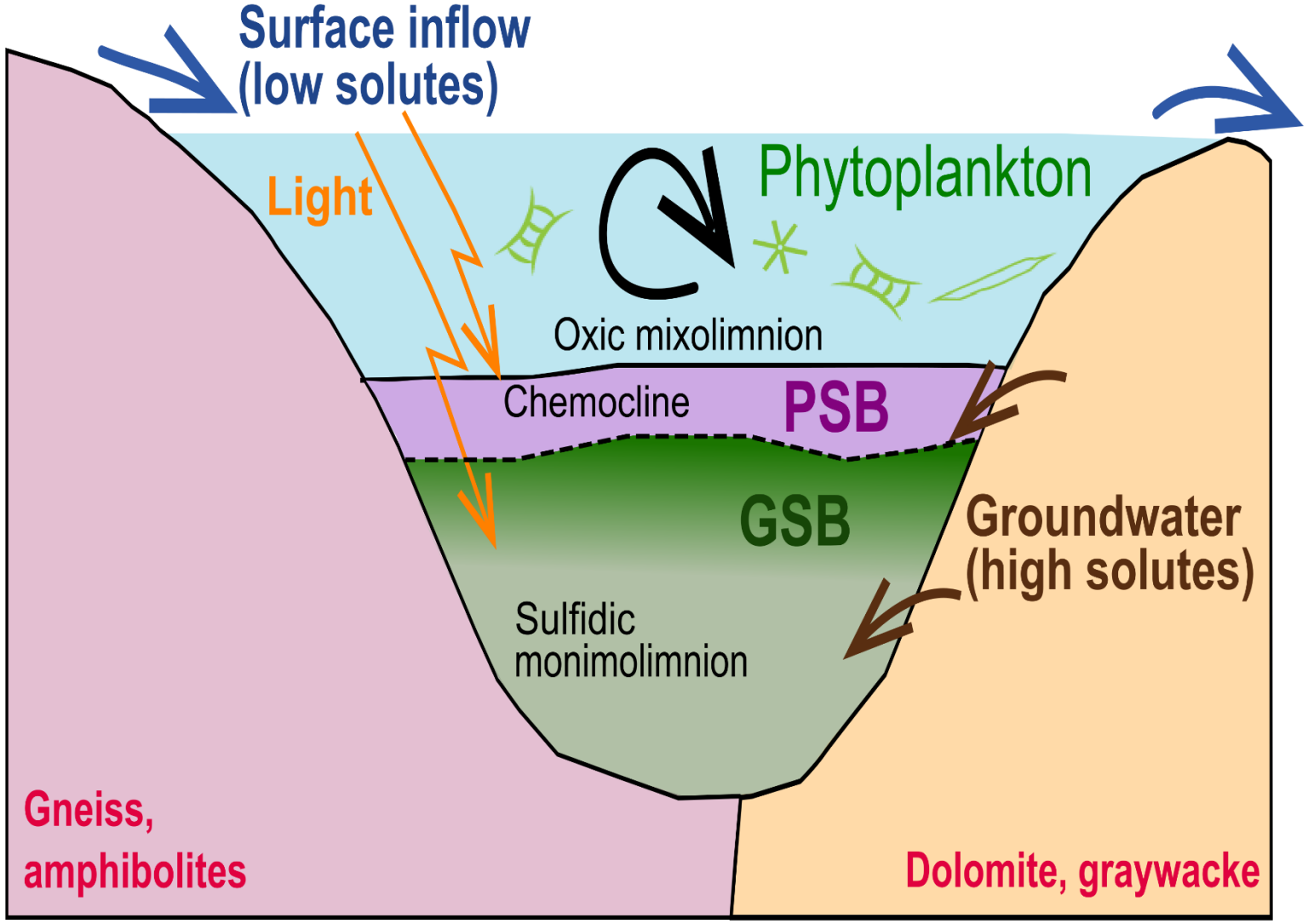
Data from Dahl et al., 2010 (*Geochim. Cosmochim. Acta*).
Figure from Wirth et al., 2013 (*Geochim. Cosmochim. Acta*)

- Permanently stratified alpine lake
- Area = 0.26 km^2
- 1926 m a.s.l.
- Sulfate-rich groundwater inflow maintains chemical and density stratification (crenogenic meromixis)

UNIVERSITÄT BERN
OESCHGER CENTRE
CLIMATE CHANGE RESEARCH

Phototrophic communities Lake Cadagno

UNIVERSITÄT BERN
OESCHGER CENTRE CLIMATE CHANGE RESEARCH



Phytoplankton (oxygenic phototrophs)

❖ **Max Absorbance @ 660-670 nm**

- Chlorophyll-*a* (and derivatives)
- Diverse carotenoids

PSB = Purple sulfur bacteria (anoxygenic phototrophs)

❖ **Max Absorbance @ 845 nm**

- Bacteriochlorophyll-*a,b* (and derivatives)
- Okenone

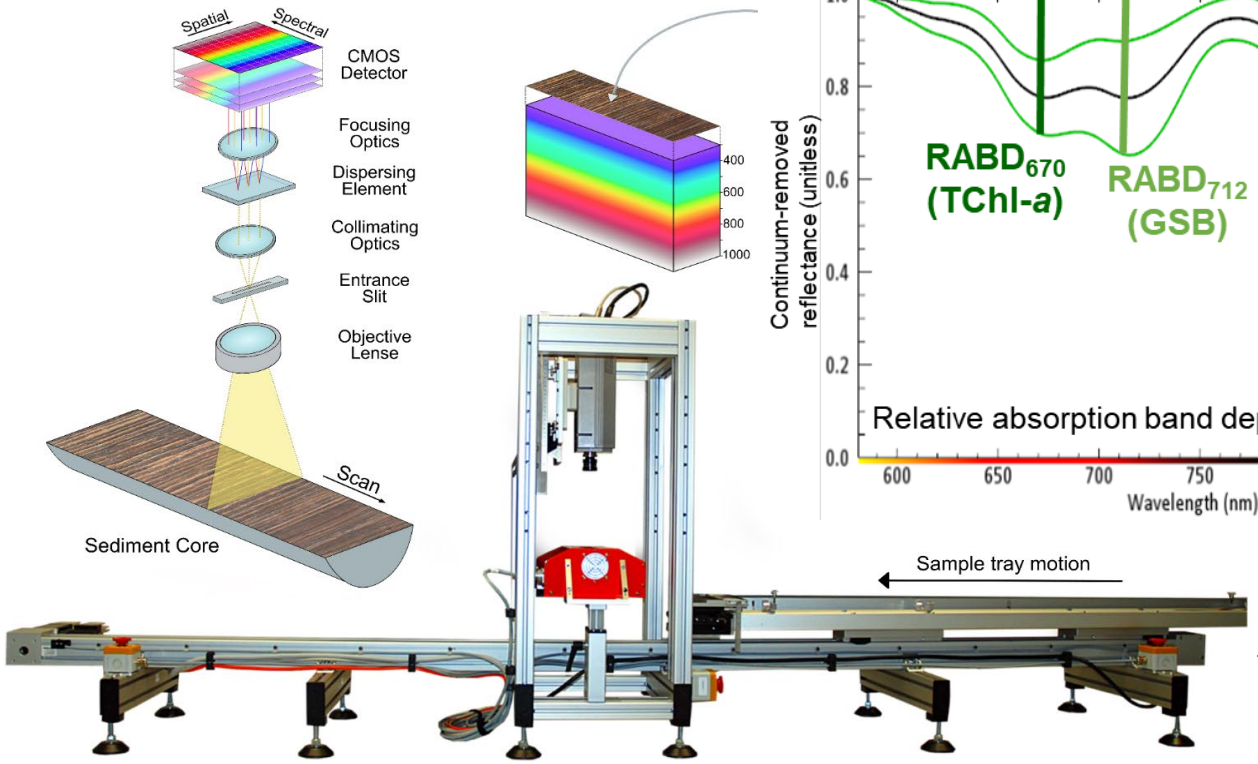
GSB = Green sulfur bacteria (anoxygenic phototrophs)

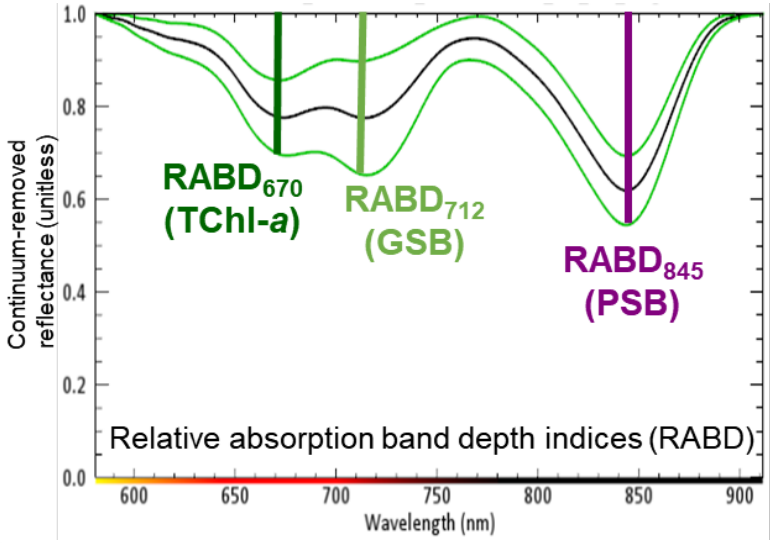
❖ **Max Absorbance @ 700-750 nm**

- Bacteriochlorophyll-*c,d,e* (and derivatives)
- Isorenieratene
- **Not previously detected with HSI!*

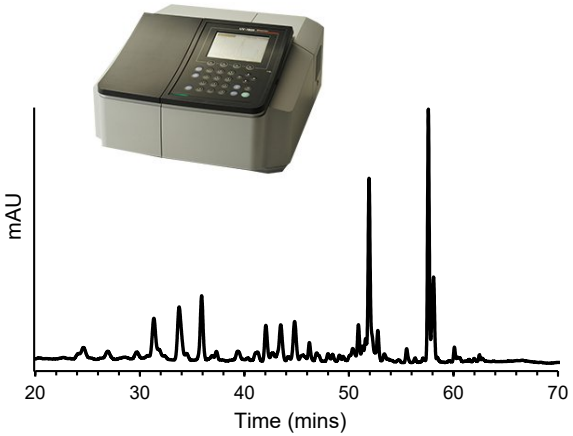
Hyperspectral imaging and pigment analysis

1) Hyperspectral imaging core scanning





2) Pigments extracted and measured with HPLC/spectrophotometer from 22 samples to verify/calibrate RABD indices



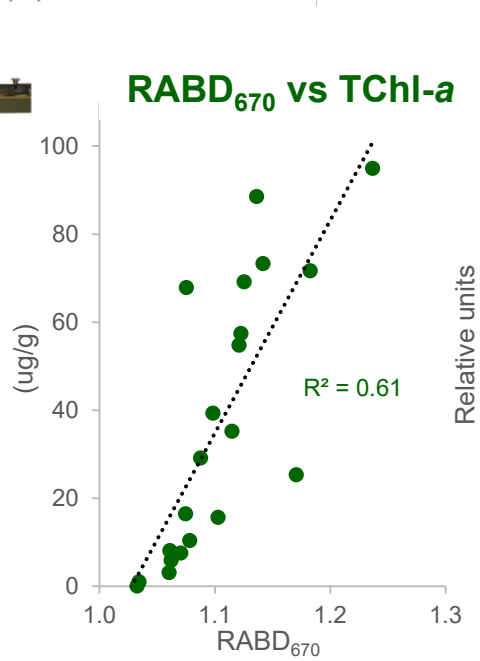
Specifications

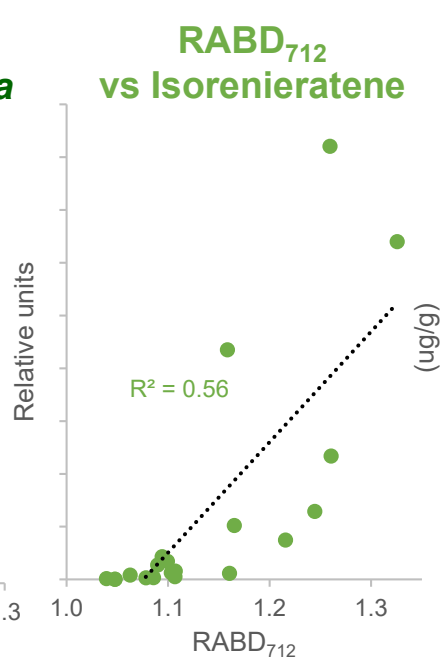
Spectral range: 400 – 1000 nm

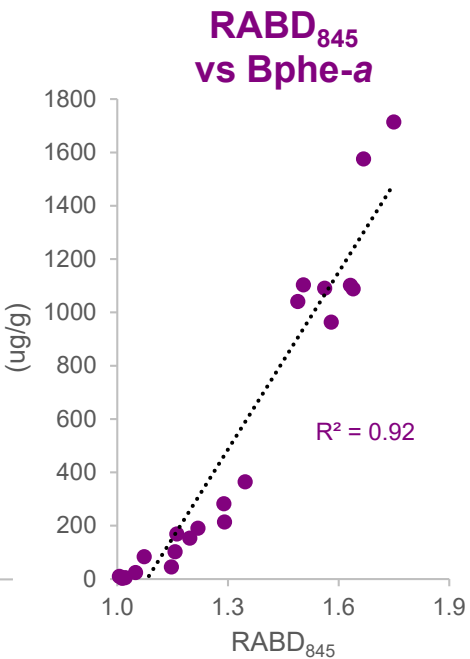
Spectral resolution: 1.6 nm

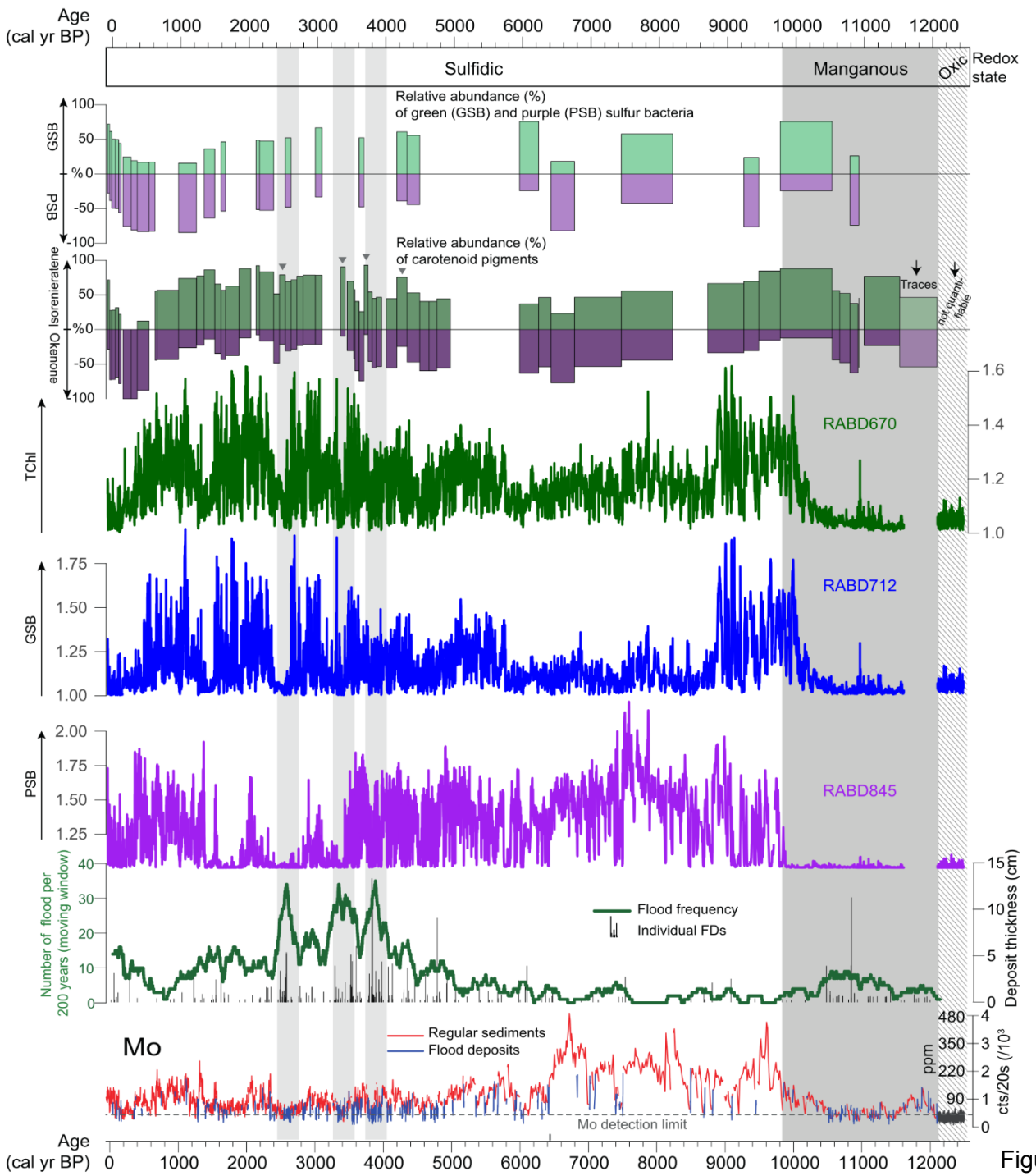
Spatial resolution: 60-100 µm

Speed: (~40 min / meter)









Key results

- Hyperspectral imaging tracks variations in phototrophic communities at high resolution
- Near continuous presence of PSB/GSB since 9.8 ka BP confirms that Lake Cadagno was meromictic and sulfidic throughout most of the Holocene (Wirth et al., 2013)
- PSB dominate from 8.8-3.4 ka BP indicating a shallow and stable chemocline
- GSB became more prevalent from 3.4-1.4 ka BP likely driven by increased turbidity and/or a deeper chemocline (driven by forest clearing and cooler temperatures)
- High-resolution data enables investigation of the response of phototrophic communities to disturbance events (GSB recover more quickly than PSB after mass movements)

UNIVERSITÄT BERN
OESCHGER CENTRE CLIMATE CHANGE RESEARCH

Figure modified from Wirth et al., 2013

Questions?

UNIVERSITÄT BERN

OESCHGER CENTRE
CLIMATE CHANGE RESEARCH

Get in Touch!

Paul.Zander@giub.unibe.ch

@zanderland33

Photo from Wikimedia commons
(CC BY-SA 3.0)