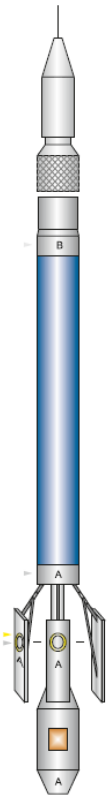
II Interpretation of downhole logging data in lake drilling projects



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PALEOVAN

SCOPSCO

IAG Leibniz Institute for Applied Geophysics

Leibniz Leibniz-Association

DFG Deutsche Forschungsgemeinschaft

Lake Van – facies characterization

Quaternary Science Reviews 104 (2014) 85–96

Contents lists available at ScienceDirect

Quaternary Science Reviews

journal homepage: www.elsevier.com/locate/quascirev

Facies characterization based on physical properties from downhole logging for the sediment record of Lake Van, Turkey

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ARTICLE INFO

Article history:
Received 31 August 2013
Received in revised form
12 January 2014
Accepted 19 March 2014
Available online 13 April 2014

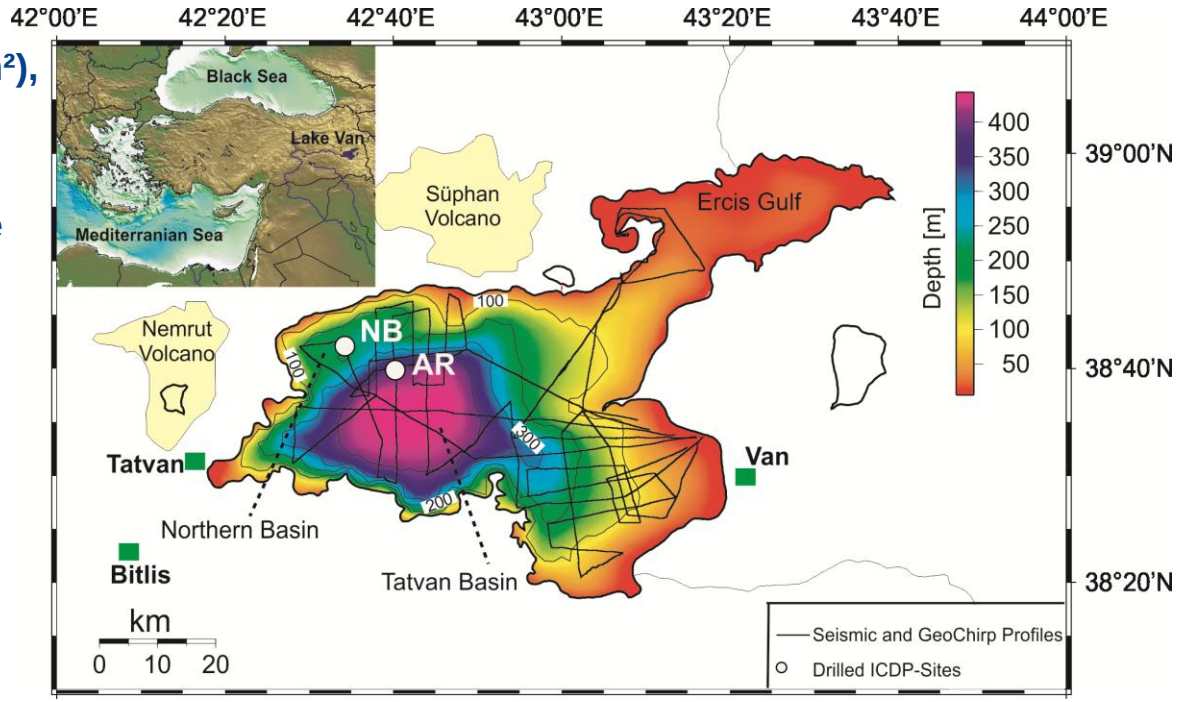
ABSTRACT

Lake Van (Turkey) is the 4th largest terminal lake in the world and is located at a key position for climatic reconstruction. The ICDP project 'PALEOVAN' is a deep-drilling campaign initiated in the summer of 2010 to enhance the understanding of paleoclimatic and paleoenvironmental conditions in the Middle East for a period of 550,000 years. Multiple coring of two sites (Northern Basin and Ahlat Ridge) at a water depth of up to 360 m has been performed. The sedimentary record is mainly composed of clayey silts and tephra deposits that were supplied by four volcanic sources: 1) the Süphan volcano, located on the

PALEOVAN project and history

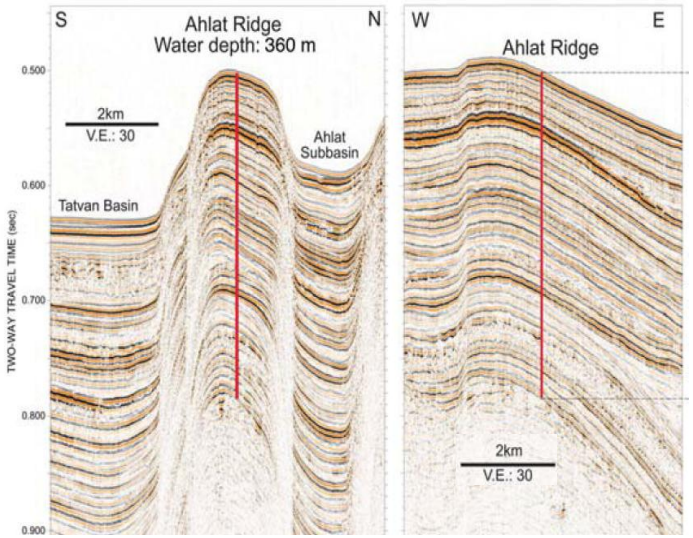
Setting

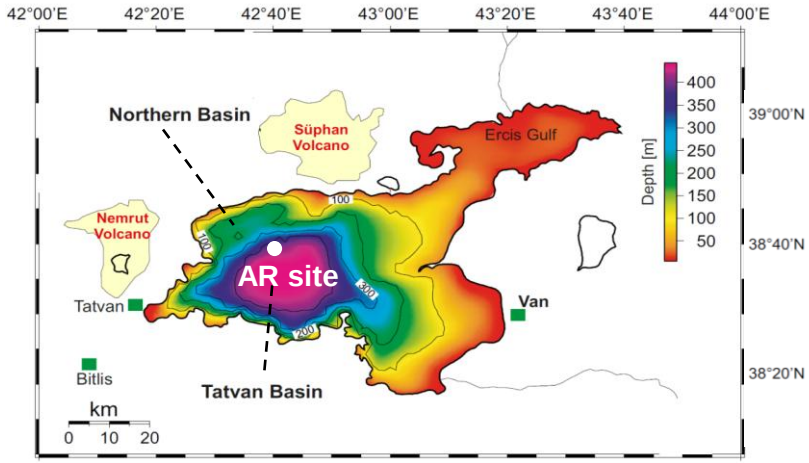
- terminal lake (surface area 3750 km²), age > 600 ka
- hydrological change recorded (lake terraces)
- surrounded by volcanoes
- first studies in 1970ies (shallow coring, seismics)
- deep coring campain in 2010 (Sites: 1. Northern Basin and 2. Ahlat Ridge)



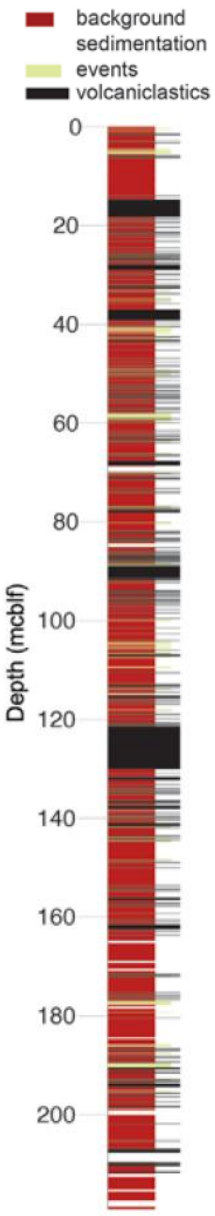
Litt et al., 2009

PALEOVAN drilling project

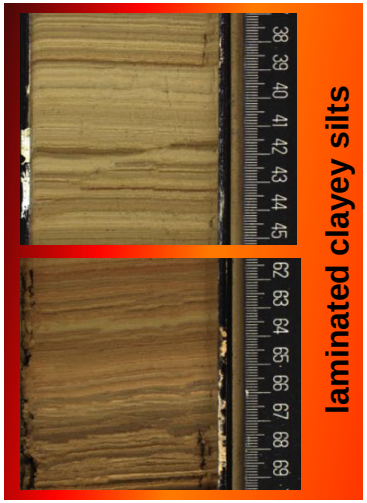


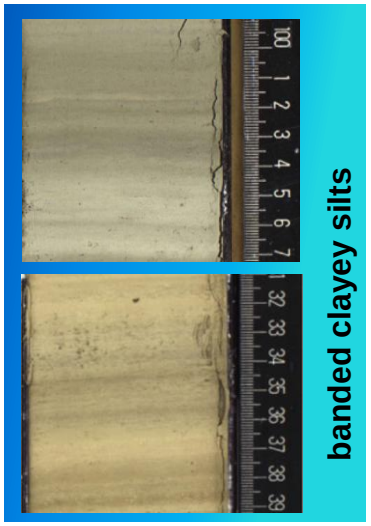


Litt et al., 2009



Litt et al., 2012



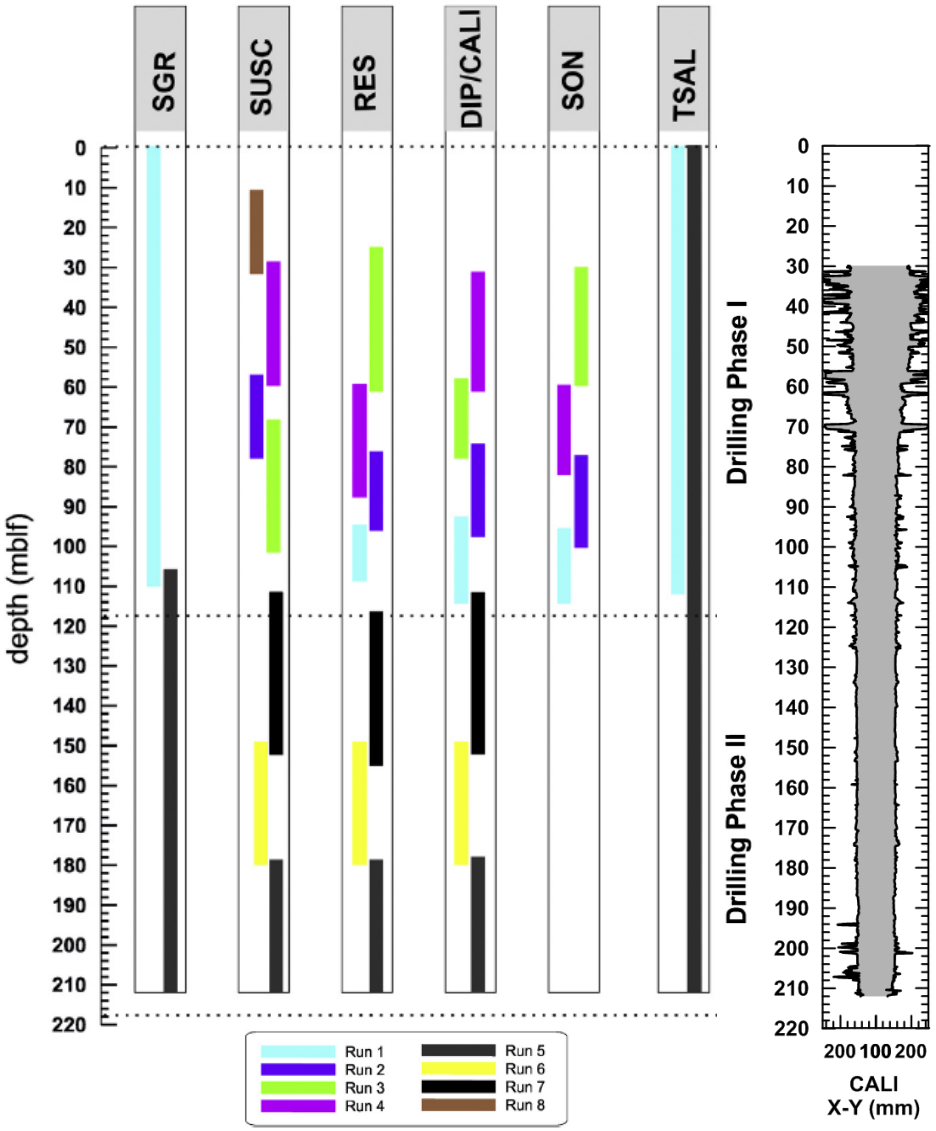


Stockhecke et al., 2014

- cores: 91% recovery, clayey silts and tephra
- composite profile: 7 parallel holes, 16 lithological units!
- clayey silts: banded, laminated, transitions, turbidites (3%)
- sands and gravel below 210 mblf

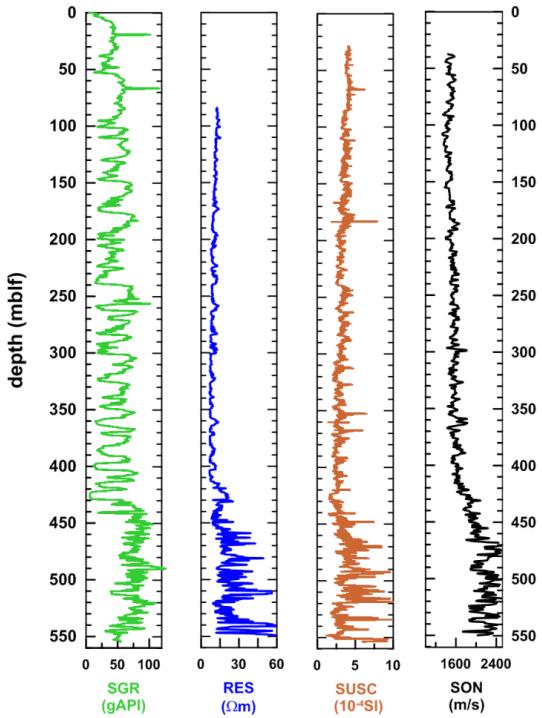
icdp-online.org

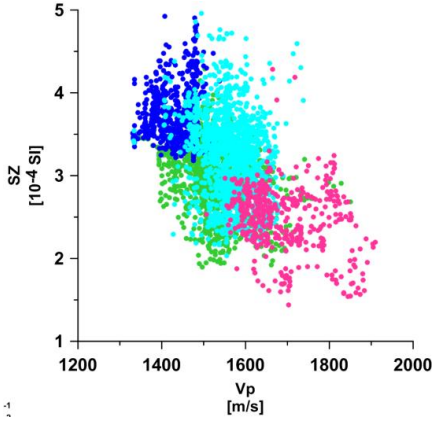
Acquisition of downhole logging data

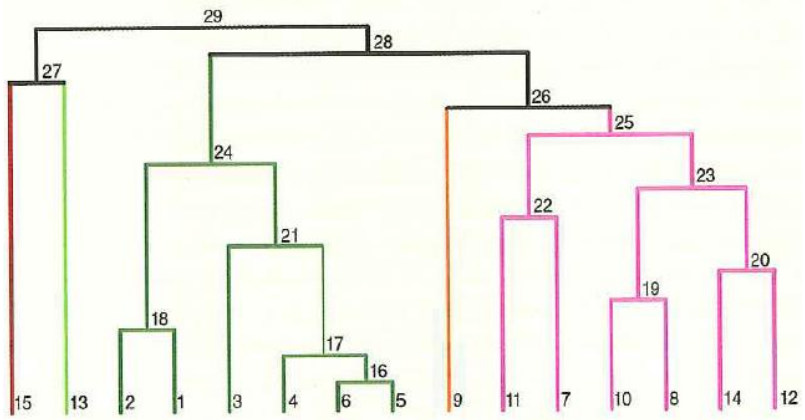


- low borehole stability (unconsolidated sediments and tephra)
- pulling of drillpipes up to 30 mblf and logging of open hole sections
- each tool = single run

Method - cluster analysis







Target

- combined interpretation of all available logging data
- continuous lithological reconstruction

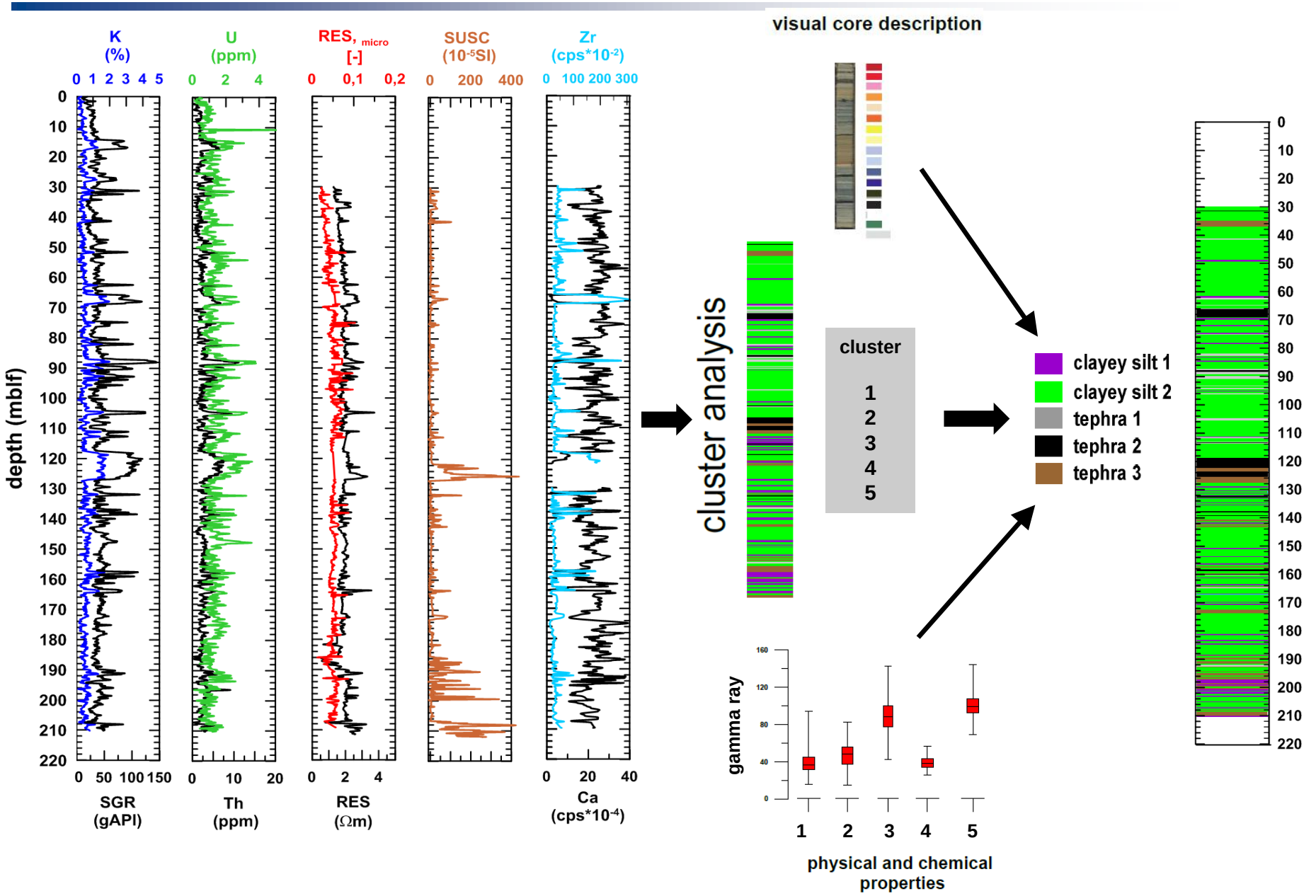
Output

- cluster (groups) with similar combination of properties
- cluster correspond to lithological unit

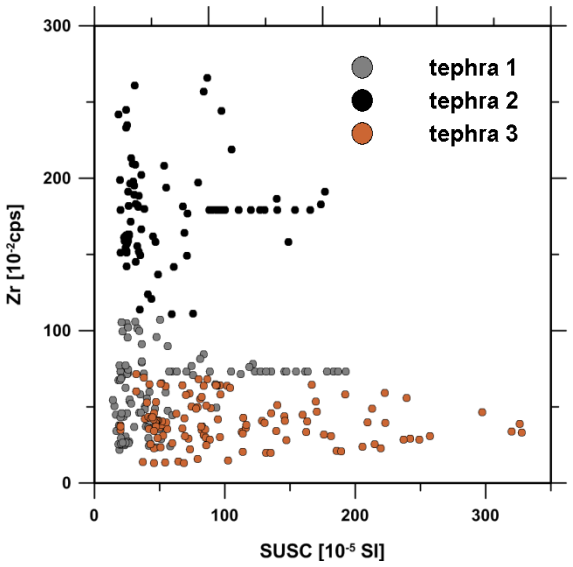
Tasks

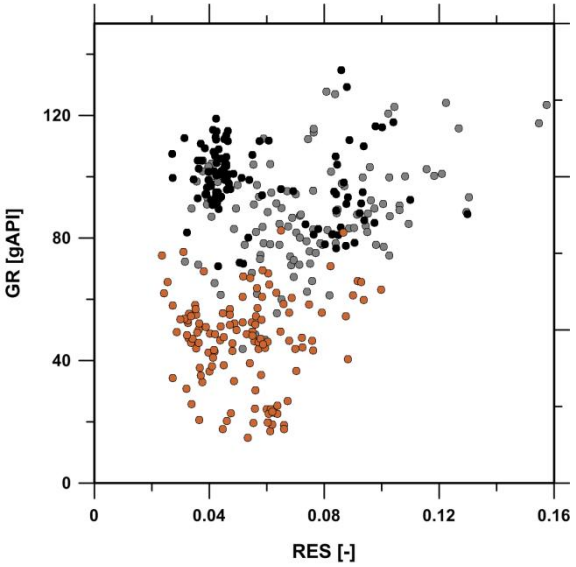
- choose number of cluster (dendrogram)
- relate cluster to lithology (core/cutting description required)

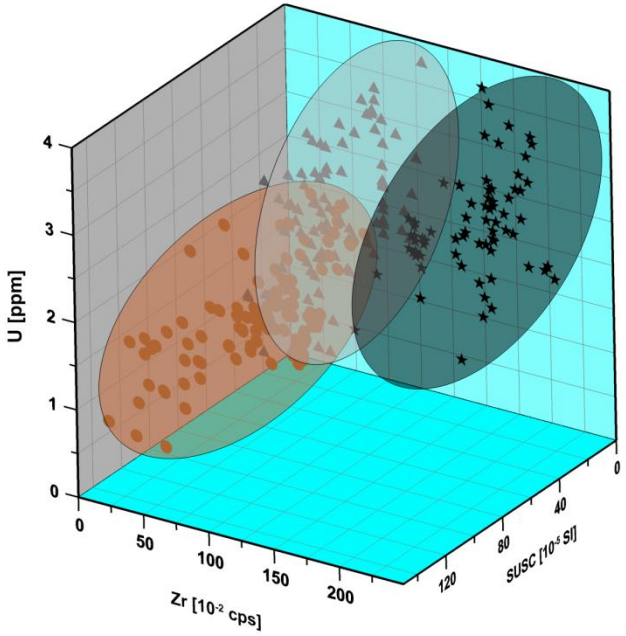
Cluster analysis of downhole and core data

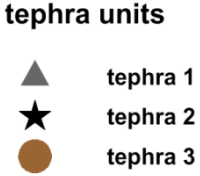


Physical and chemical properties of tephra









Volcanic sources and their dominant compositions

(1) Nemrut volcano, trachytic to rhyolitic.

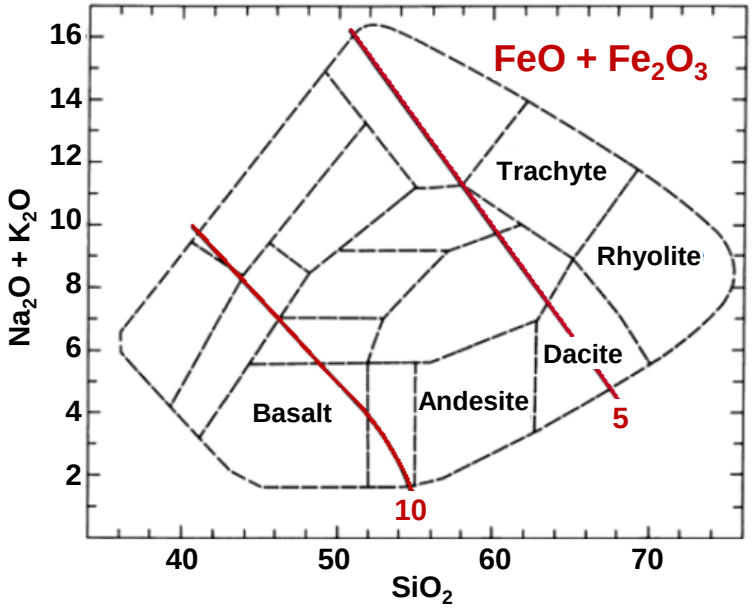
(2) Süphan volcano, dacitic to rhyolitic.

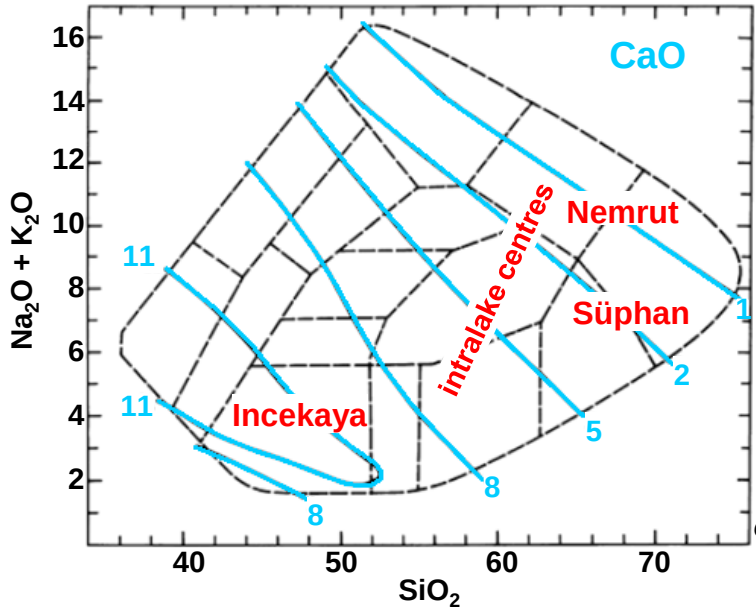
(3) Incekaya, basaltic.

(4) Intralake eruptive centres, intermediate to trachytic.

correlation of tephra units 1-3 with volcanic sources / dominant volcanic composition?

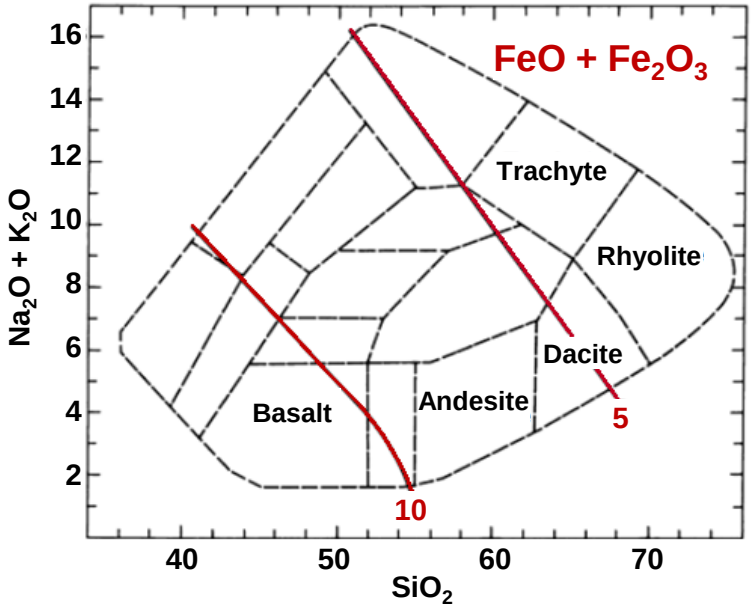
Linking of tephra layers to dominant volcanic composition

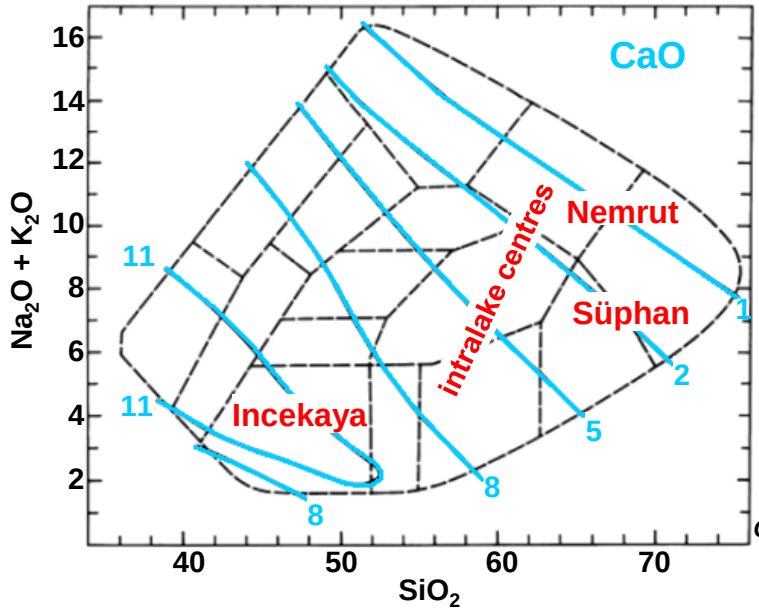




Cox et al., 1979

Linking of tephra layers to dominant volcanic composition

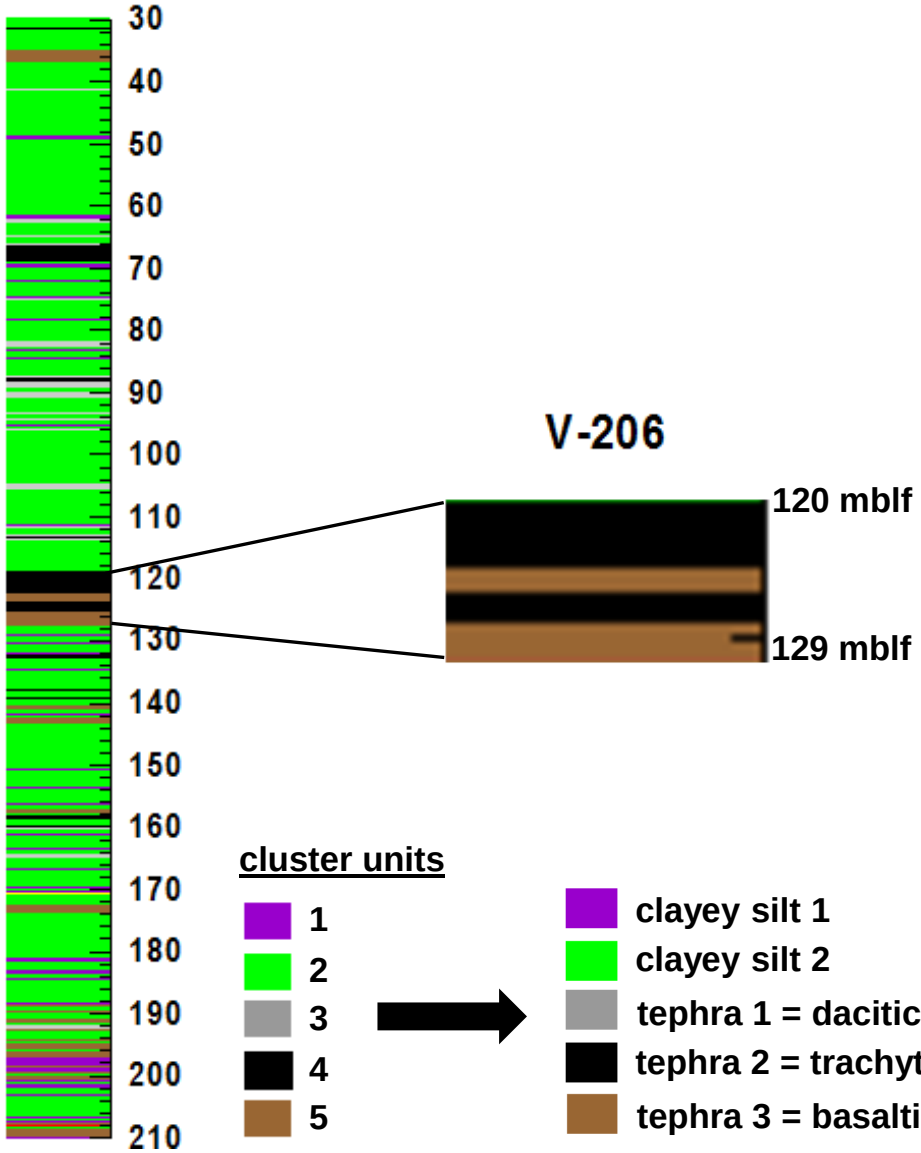




Cox et al., 1979

Classification	dacitic-rhyolitic (Süphan?)	trachytic-rhyolitic (Nemrut?)	basaltic (Incekaya?)	Intralake centres	Log-/XRF response
$Na_2O + K_2O$	med.	high	low	variable	GR/K
$FeO + Fe_2O_3$	med.	low	high		SUSC
CaO	low	low	high		Ca
Zr	med. - high	high	low		Zr
Th	med. - high	med. - high	low		Th
link to cluster analysis	tephra 1	tephra 2	tephra 3	??	

Characterization of volcanic facies



continuous reconstruction of the record from 30 – 210 mblf

compositional evolution:

210 – 125 m:
more basaltic products (Incekaya)

125 – 30 m:
more dacitic and rhyolitic/trachytic products (Nemrut & Süphan)

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PALEOVAN

Lake Ohrid – Age depth-model

Biogeosciences Discuss., 12, 7671–7703, 2015
www.biogeosciences-discuss.net/12/7671/2015/
doi:10.5194/bgd-12-7671-2015

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Discussions
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Age depth-model for the past 630 ka in Lake Ohrid (Macedonia/Albania) based on cyclostratigraphic analysis of downhole gamma ray data

H. Baumgarten[1], T. Wonik[1], D. C. Tanner[1], A. Francke[2], B. Wagner[2], G. Zanchetta[3], R. Sulpizio[4], B. Giaccio[5], and S. Nomade[6]

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Received: 18 February 2015 – Accepted: 13 April 2015 – Published: 22 May 2015

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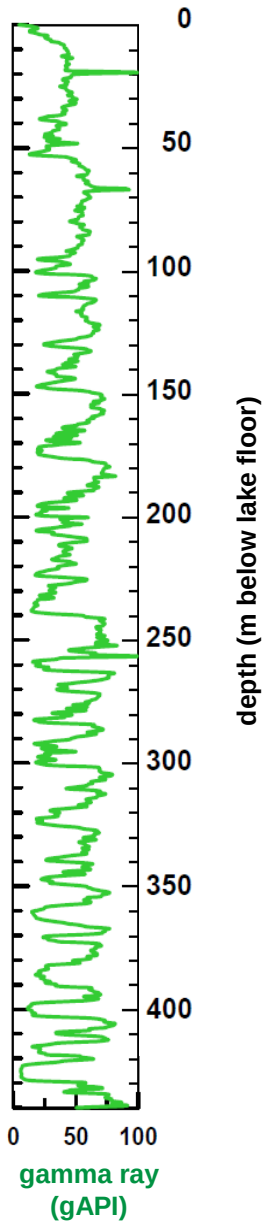
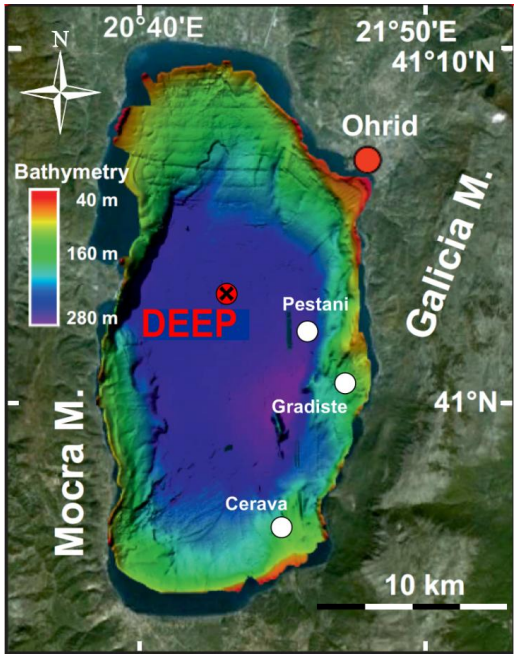
Published by Copernicus Publications on behalf of the European Geosciences Union.



SCOPSCO drilling project

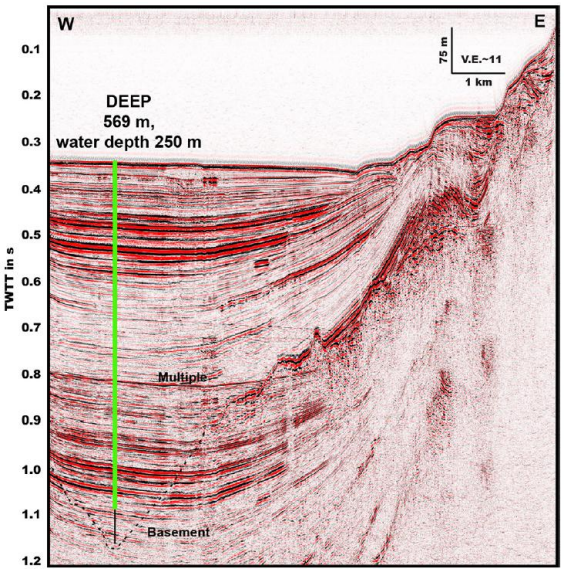


SCOPSCO: Scientific Collaboration On Past Speciation Conditions in Lake Ohrid

ICDP campaign in 2013

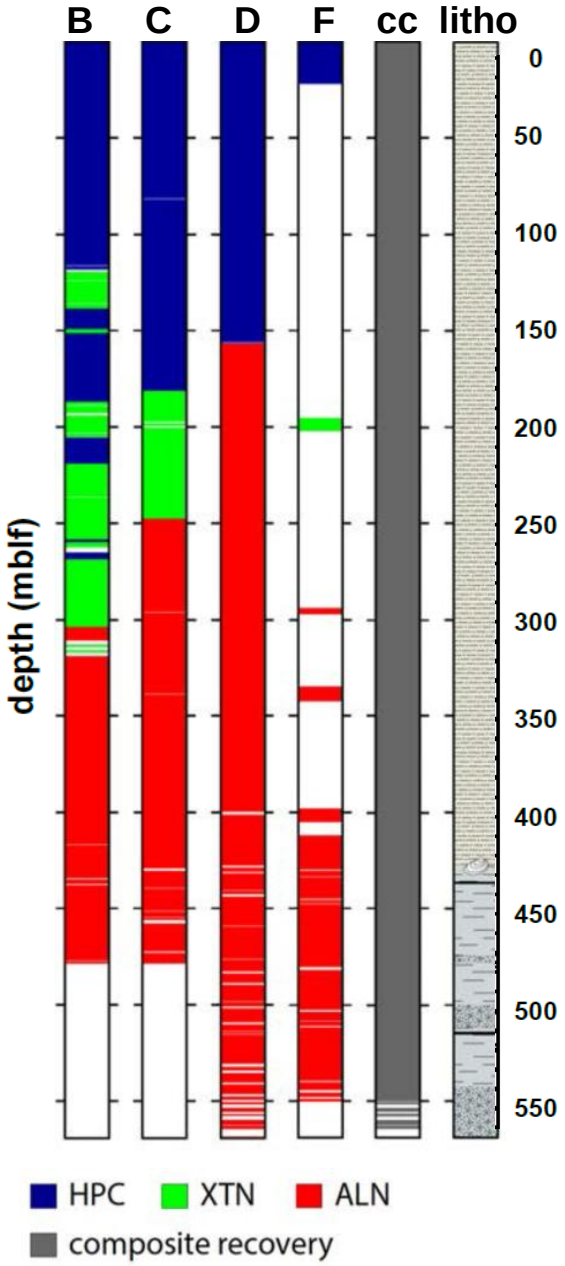
key objective:

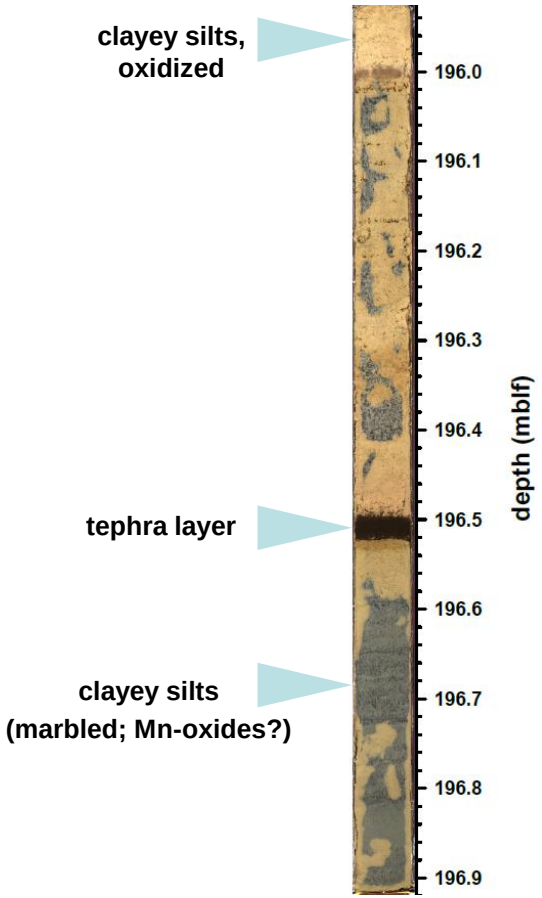
reconstruction of Lake Ohrid's climatic, tectonic and evolutionary biological history



Wagner et al., 2014

Sediment cores





Coring tools

HPC: hydraulic piston,
XTN: extended nose,
ALN: Alien

1526 m of cores, 95% recovery

Sediment facies

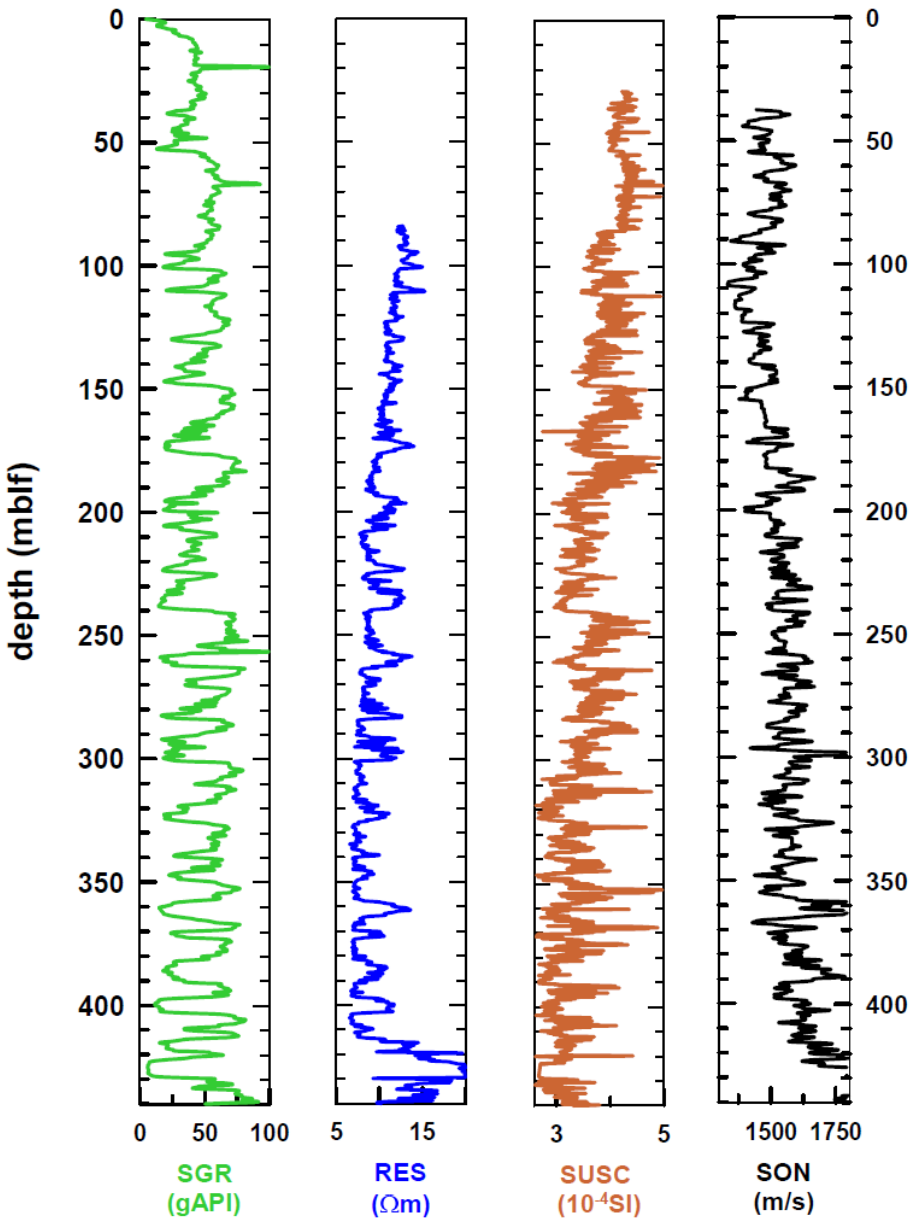
0 – 433 m: pelagic (clayey silt + tephra layers, range of cm)

A) high detrital clastic-content, low carbonate

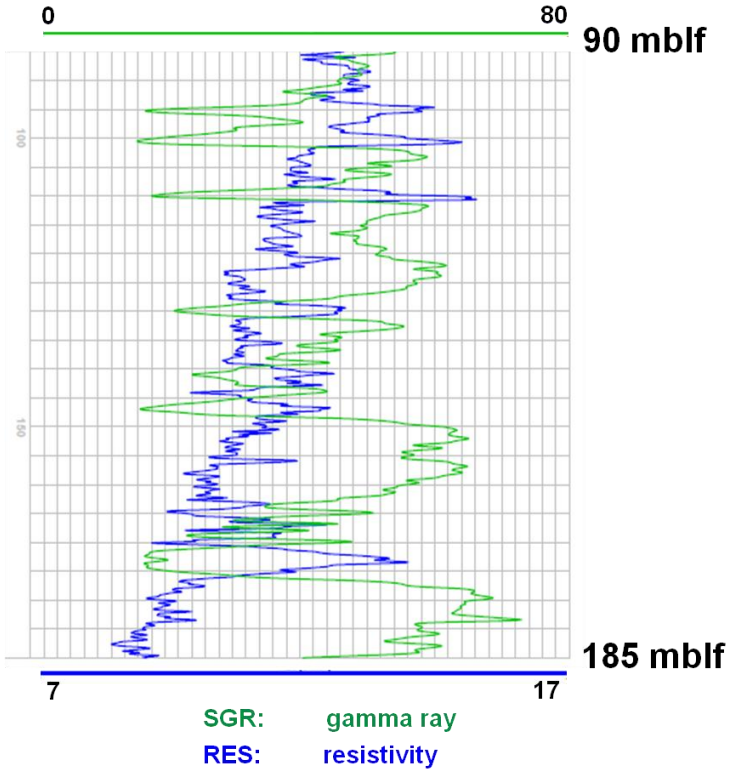
B) high carbonate-content, low clastics

> 433 m: shallow water (gravel, silt, sand)

Downhole logging data 0 – 433 m: pelagic facies



Detail enlargement of SGR and RES: negative correlation



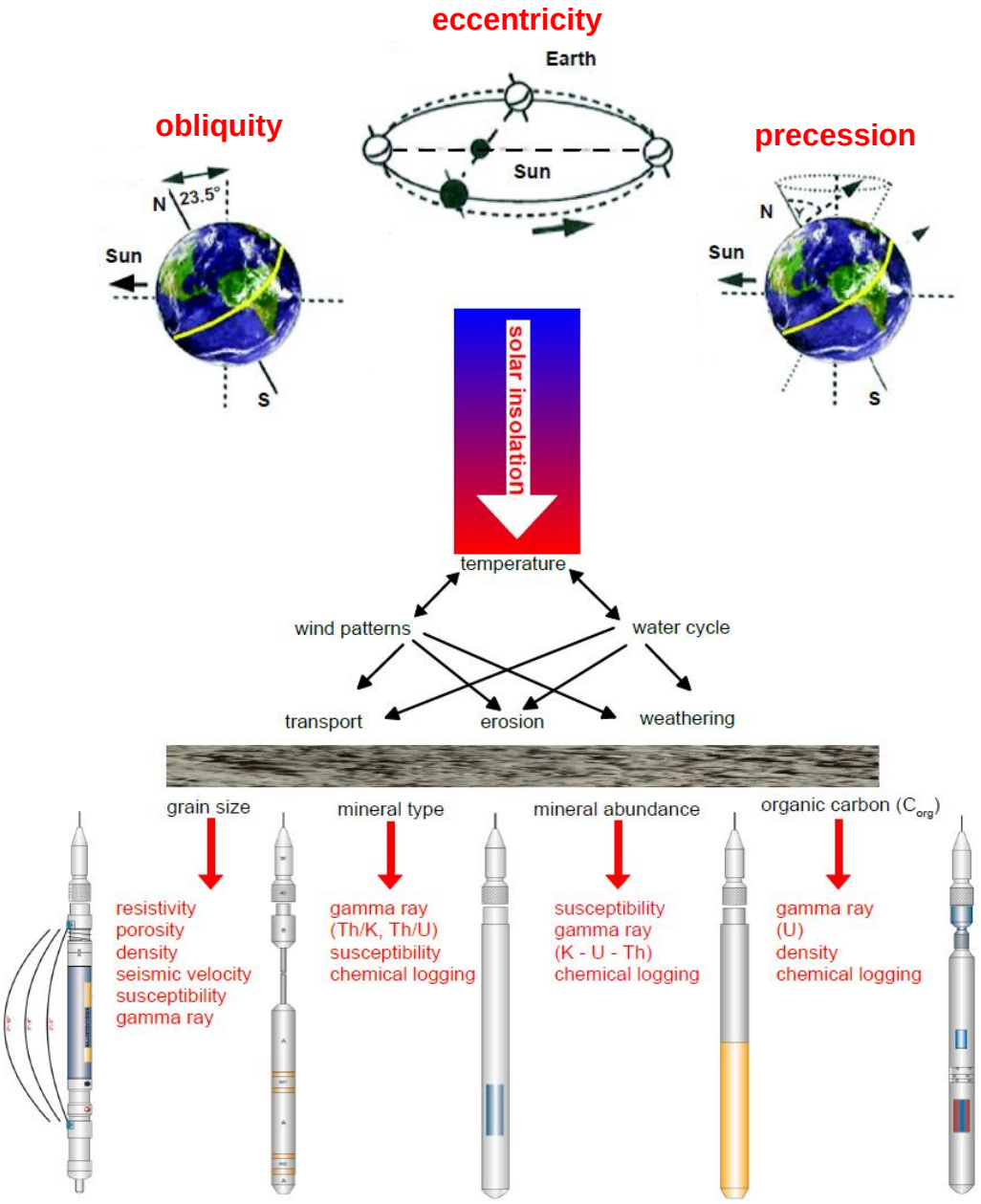
cyclicity in SGR, RES, SUSC, SON and structural characteristics

alternation of:

A) high detrital clastic-content, low carbonate

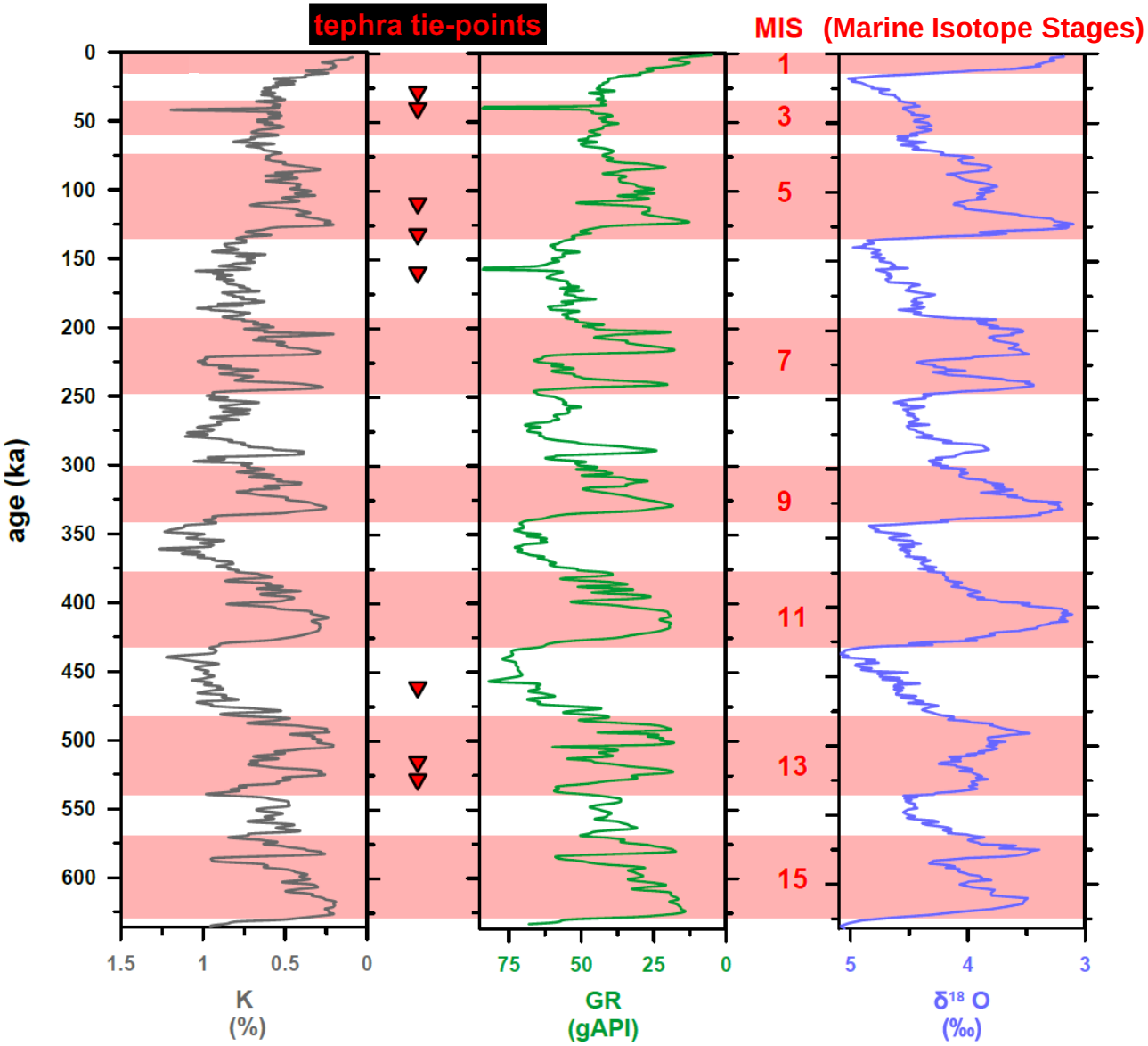
B) high carbonate-content, low clastics

Orbital cycles from downhole logging



- study of environmental proxies from sediment cores (element distribution, pollen,…)
- temporal framework required, use of dating methods and tuning
- cyclostratigraphic studies can be used to construct age depth-models

Correlation of GR and K with $\delta^{18}O$ (0 to 240 mblf)



8 age depth-points

from tephrostratigraphy

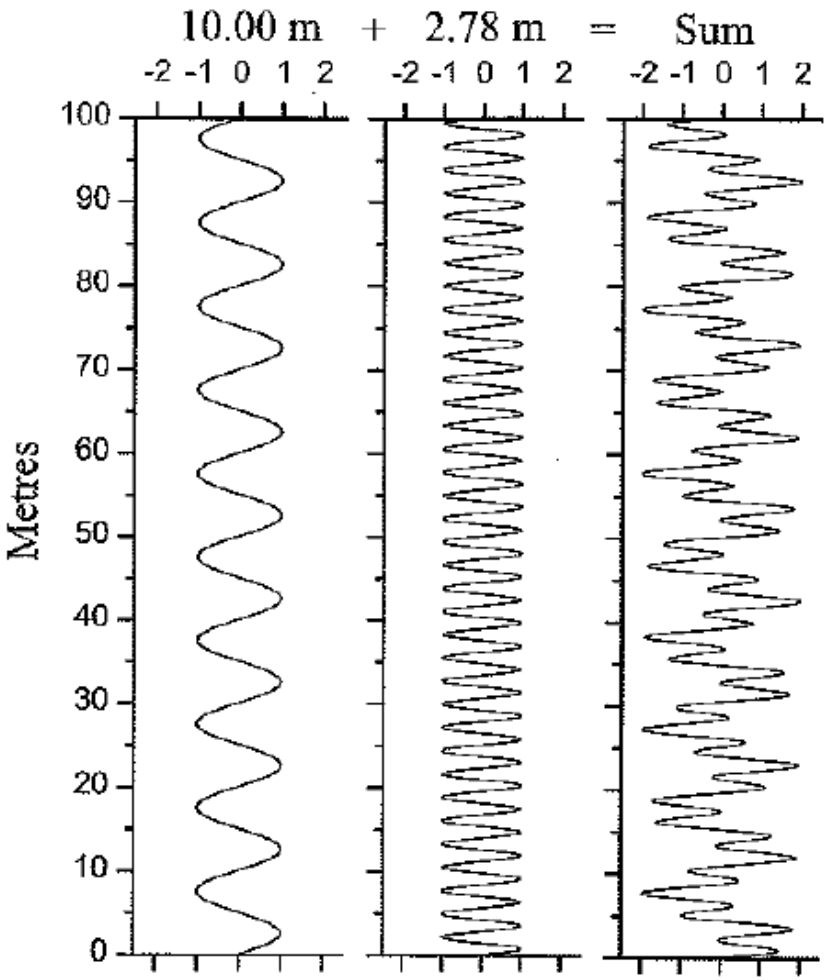
<u>depth matching:</u>

1) K (SGR-logging with XRF-scanning)

2) susceptibility (downhole with Multi Sensor Core Logging)

Method - spectral analysis

Synthetic data-set and spectral components



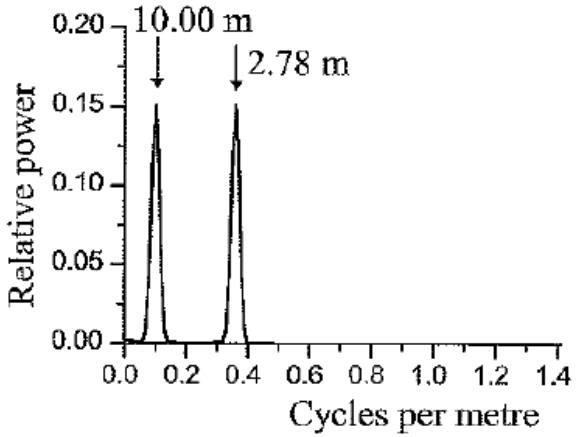
Weedon, 2003

data contains cycles of different wavelengths

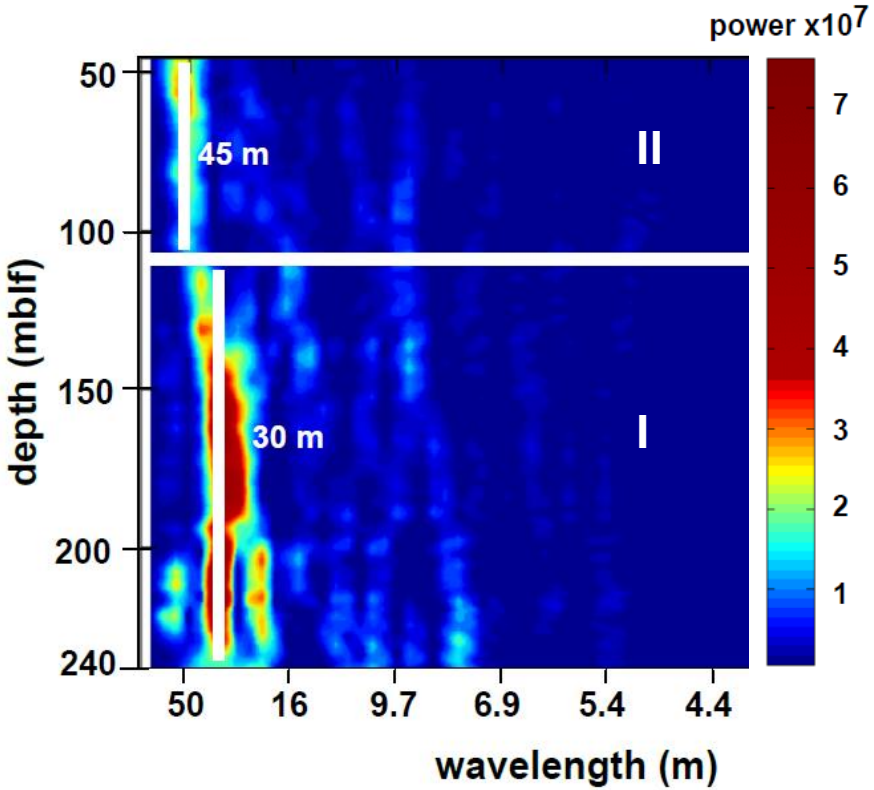
target: determination of wavelength and signal intensities

Spectral analysis

Energy level and frequency of contained signals



Evolution of cycles and intervals



spectral peaks detected (= cyclicities)

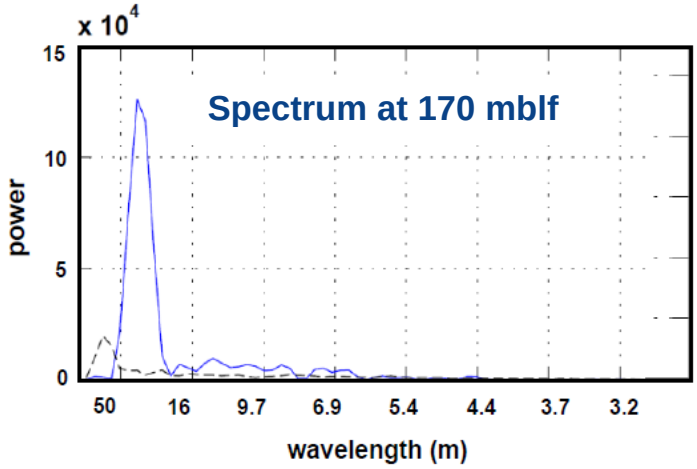
differences in spectral characteristics

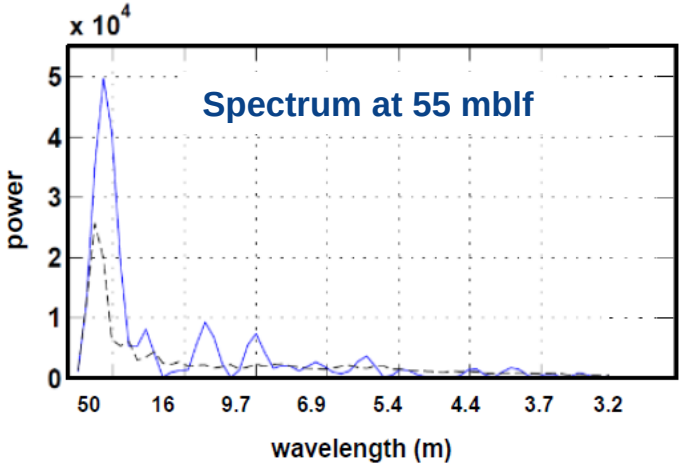
➞ subdivision at about 110 mblf

<u>length of intervals</u>

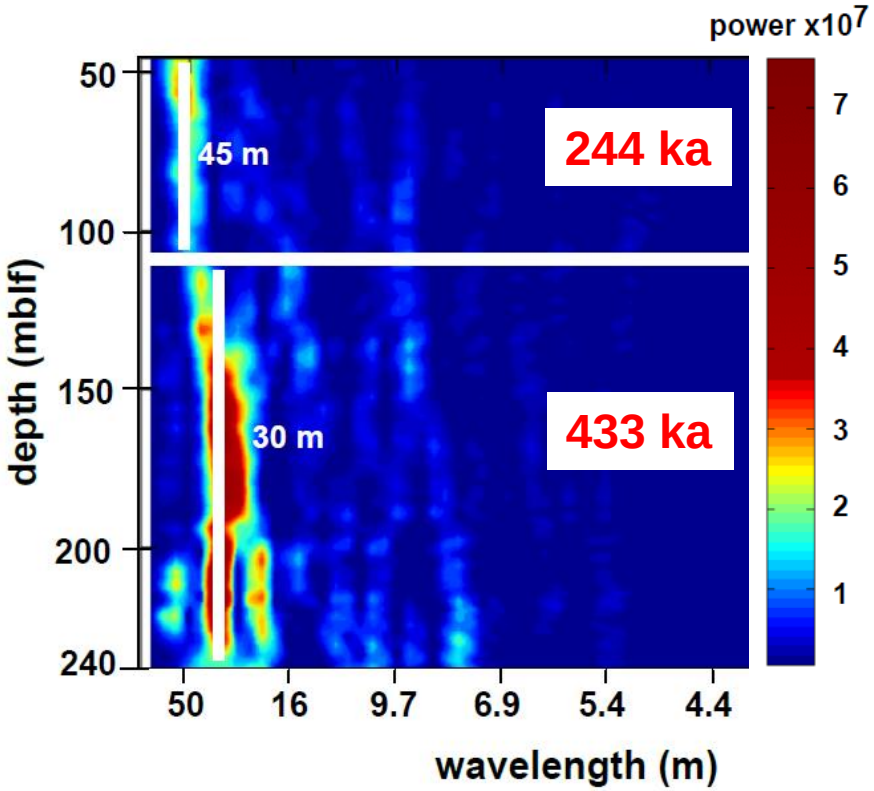
I: 130 m

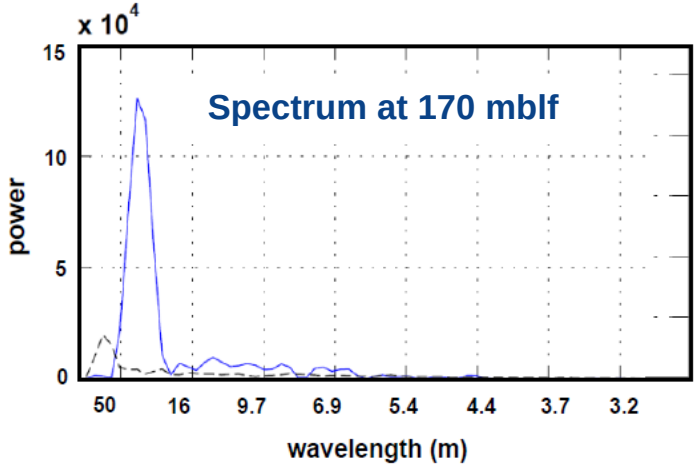
II: 110 m





Sedimentation rates and duration of desposition





dominance of 100 ka cycle in sedimentary records

(1) sedimentation rate [cm/ka]

= wavelength [m] / cycle [ka]

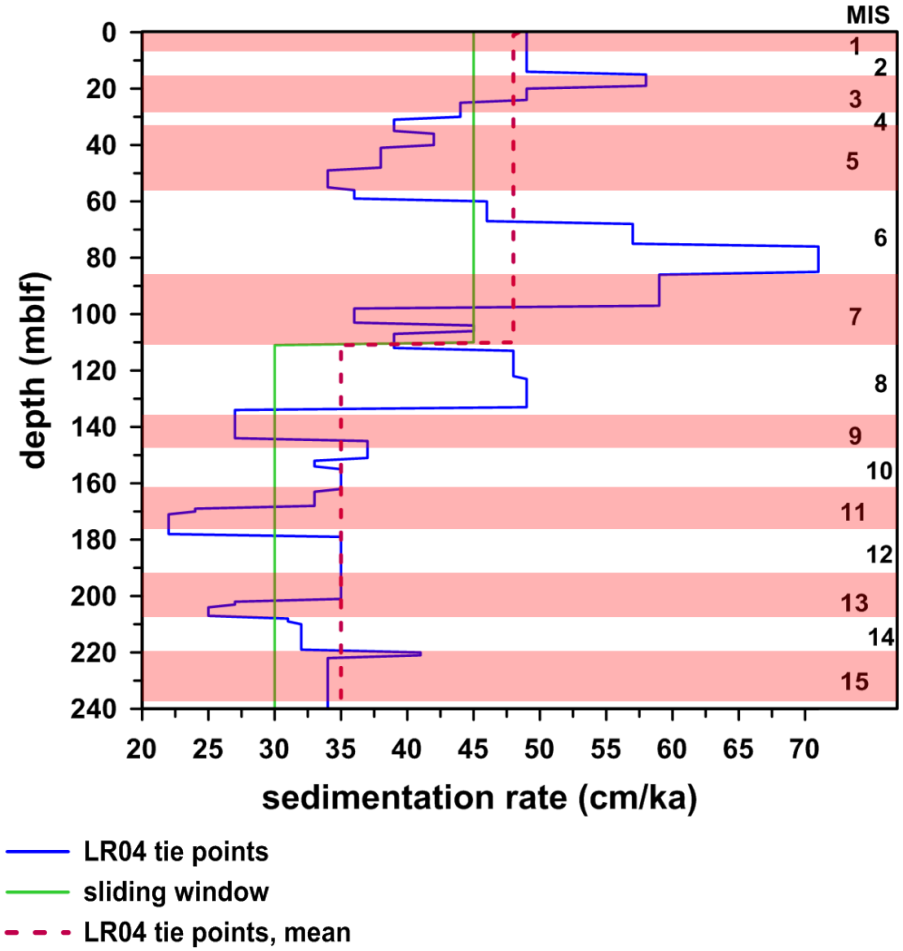
interval I: 45 m ≡ 100 ka → **45 cm/ka**

interval II: 30 m ≡ 100 ka → **30 cm/ka**

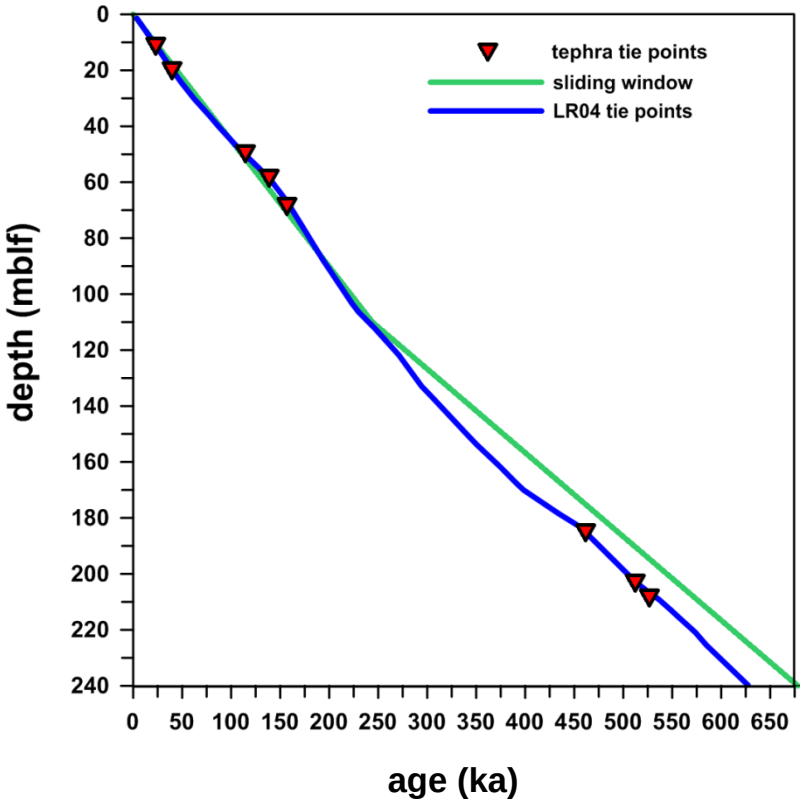
(2) duration of deposition [ka]

= length of interval [m] / sedimentation rate [cm/ka] = **677 ka**

Sedimentation rates and age depth-model



key objective of the project!



LR04 tie points: 22 – 70 cm/ka

higher accumulation of clastics compared to sediments with high carbonate content

duration of deposition:

1) tie points: 630 ka

2) sliding window: 677 ka