Evaluation of ^{210}Pb-based radiochronology models at four deep basins in Aegean Sea

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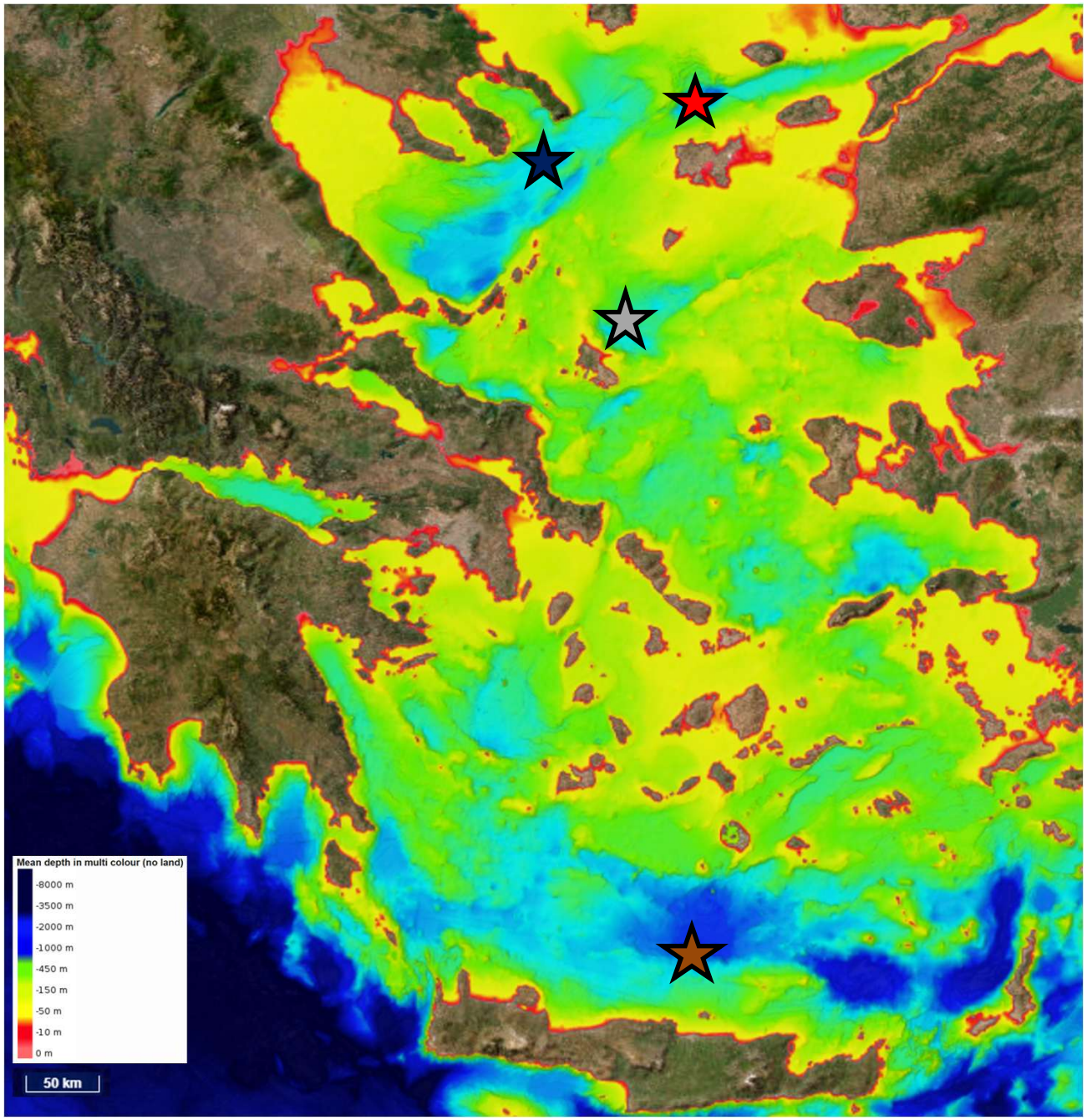
Outline

- Motivation
- Study areas: 4 deep basins of the Aegean Sea
- Methodology - Dating models
- Results
- Conclusions
- Perspectives

Motivation

- Deep Aegean basins are considered semi-enclosed systems (with restricted exchange with the open ocean), making them suitable environments for studying:
  - ❖ historical events and trends associated with past geophysical and/or anthropogenic activity (landslides, seismic activity, floods)
  - ❖ cycles/trends of biogeochemical variables (Cs, microplastics, carbon, eDNA)

- The suitability of conventional dating models (based on ^{210}Pb and ^{137}Cs) in four deep basins was investigated, where different depositional conditions may influence sediment accumulation rates



Study areas

Lemnos basin

1550 m

Athos basin

1180 m

Skyros basin

1020 m

Cretan basin

1500 m

Sample preparation

Skyros (55 cm)

Athos (45 cm)

Lemnos (40 cm)

Cretan (30 cm)

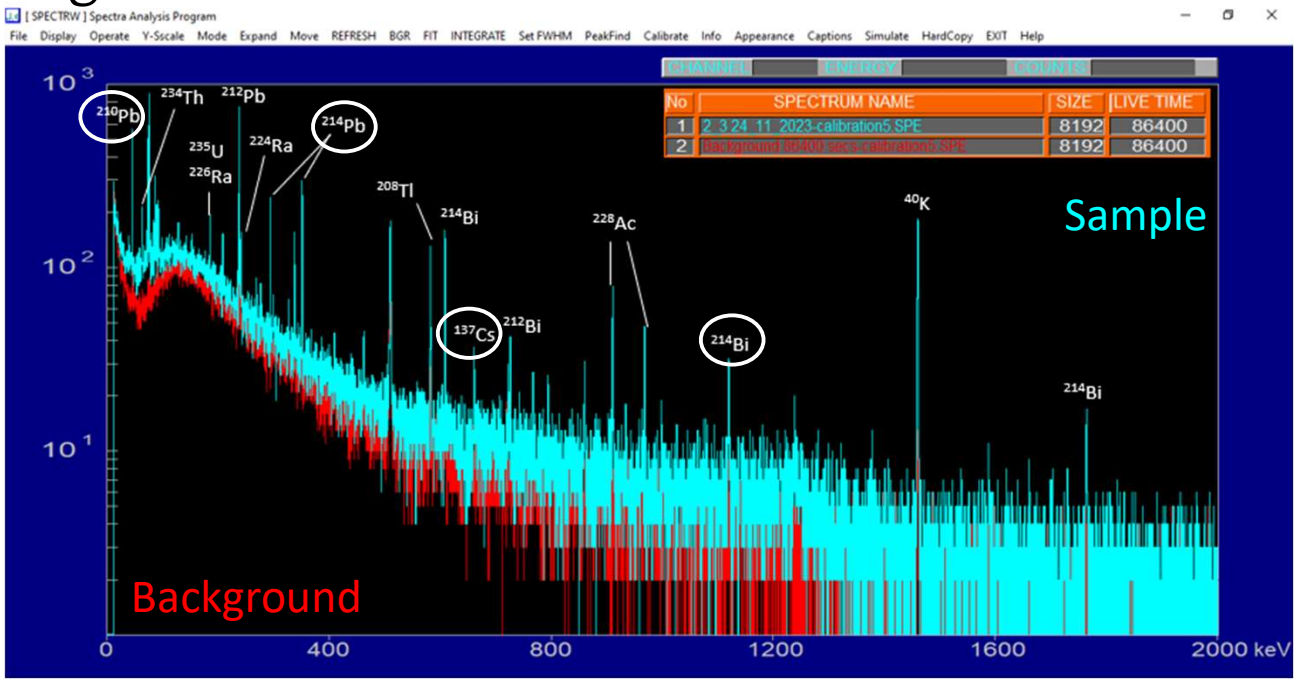
Deeper sediment layers correspond to older ages

The samples:

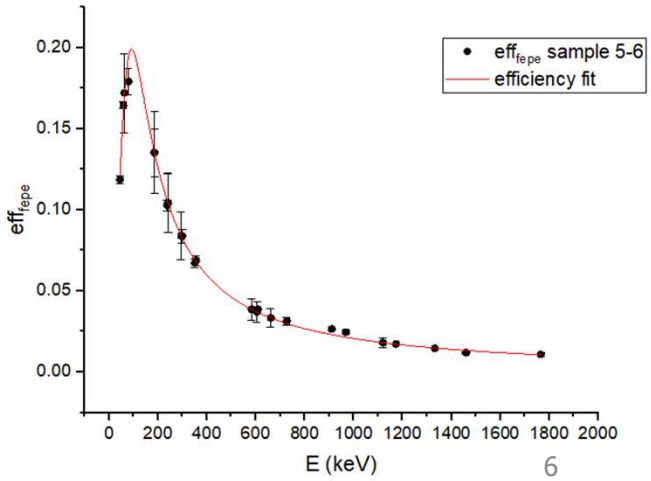
- were dehydrated
- ground into a fine powder, using an agate pestle
- placed into sealed cylindrical containers for 21 days

Gamma-ray spectrometry

HPGe detector, shielding

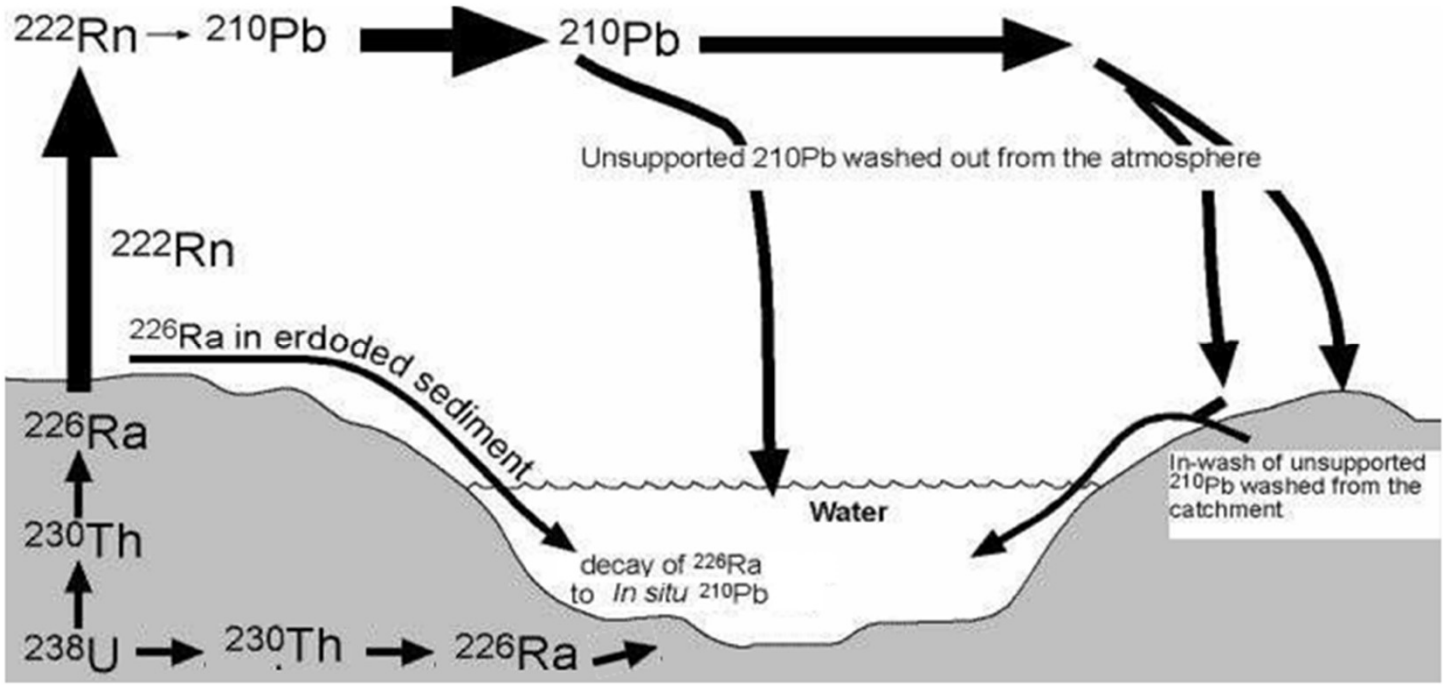


- Spectroscopy: SPECTRW software
- Photopeaks of interest: ^{210}Pb (46 keV), ^{214}Pb (342 keV), ^{214}Bi (609 keV), ^{137}Cs (661 keV)
- Calibration: reference source (IAEA-385)
- Corrections: self-absorption, summing (EFFTRAN)



Sediment chronology with radiotracers

- Sediment dating with ^{210}Pb provides chronological information for 150 years ($T_{1/2}$=22.3 y)
- Pathways of ^{210}Pb in the aquatic sediment



- ❖ Supported $^{210}Pb_{sup}$: ^{226}Ra decay in sediment $\mathbf{^{210}Pb_{sup} = {}^{226}Ra}$
- ❖ Excess $^{210}Pb_{ex}$: ^{222}Rn decay in the air (^{210}Pb dry or wet deposition) and ^{226}Ra in the water column $\mathbf{^{210}Pb_{ex} = {}^{210}Pb_{Total} - {}^{226}Ra}$

Dating models - assumptions

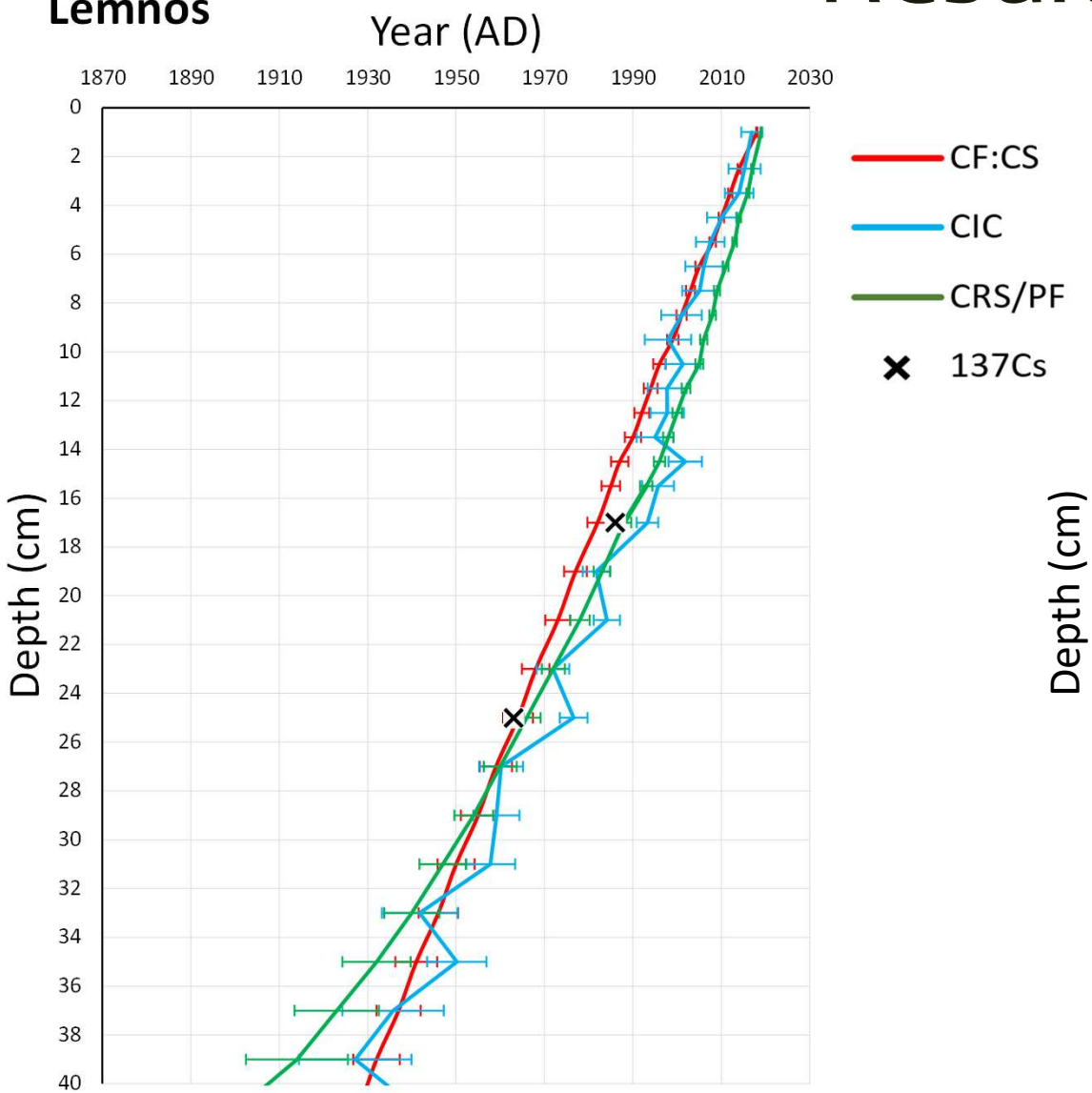
- Sedimentation models

  Based on $^{210}Pb_{ex}$ activity vertical distribution

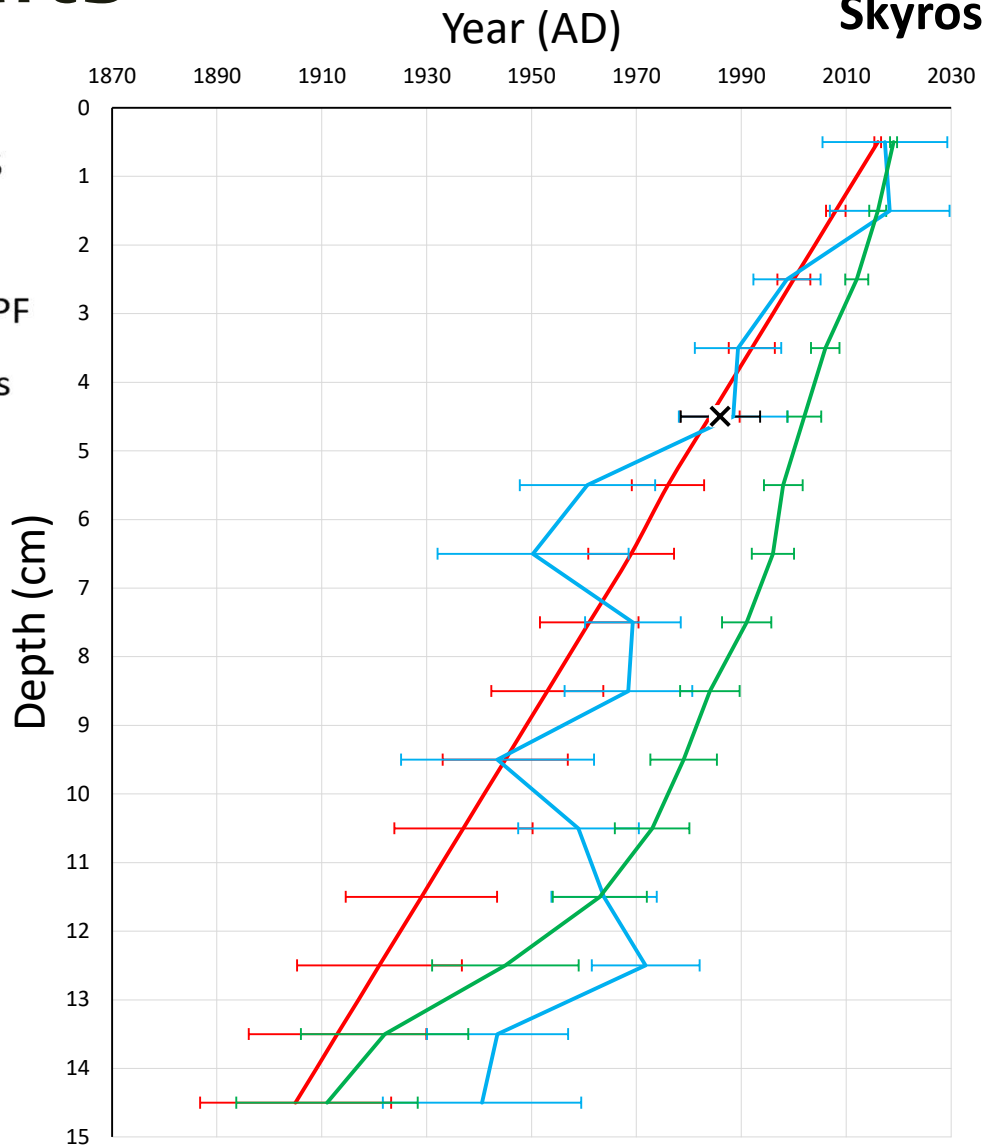
Model ($A = \frac{F}{S}$)	Activity $^{210}Pb_{ex}$ (Bq/kg)	Accumulation Rates Sediment - SAR (cm/y) or Mass - MAR (g/cm² y⁻¹)	Flux $^{210}Pb_{ex}$ (Bq/cm² y)
CFCS (Constant Flux-Sedimentation)	constant	constant	constant
CRS (Constant Rate of Supply) **PF** (Periodic Flux)	variable	variable	constant
CIC (Constant Initial Concentration)	constant	variable	variable

Results

Lemnos



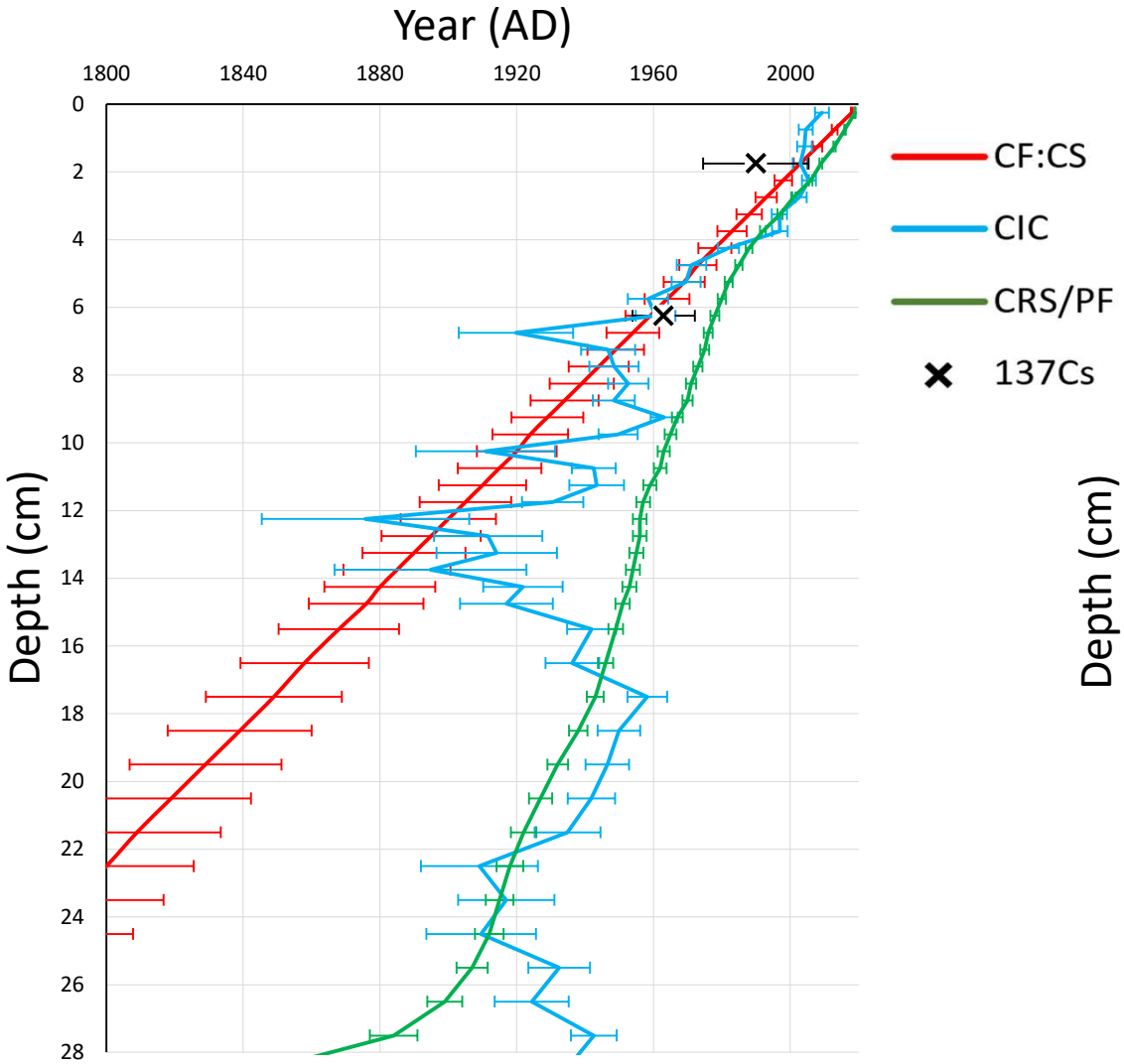
Skyros



Models' agreement: shows relatively stable depositional conditions

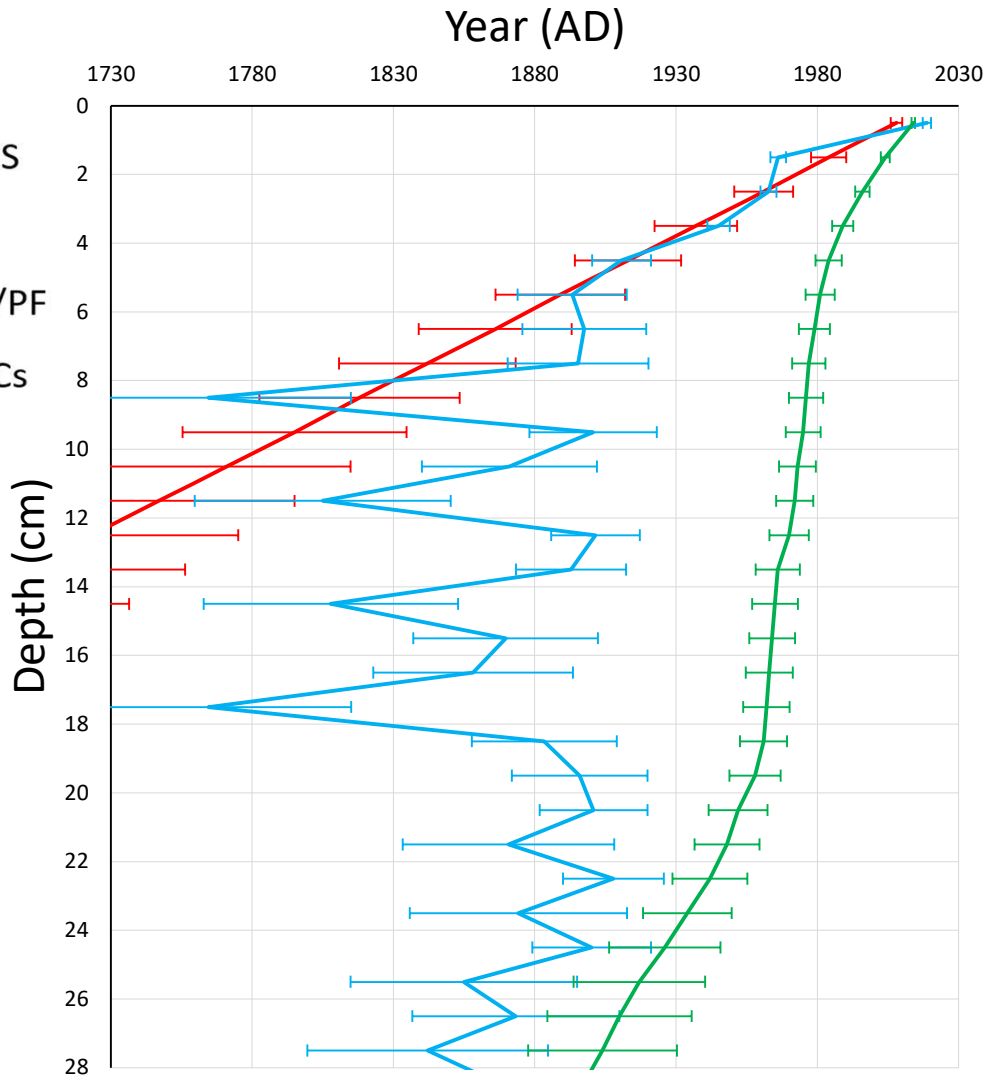
Results

Athos



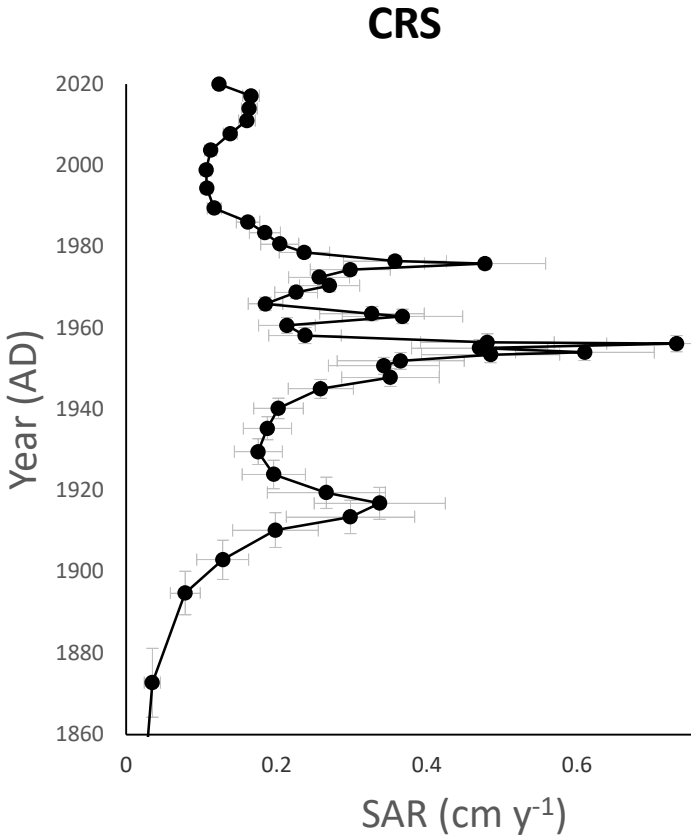
Models' discrepancy: reflects temporal variations in sedimentation dynamics (potentially geological events)

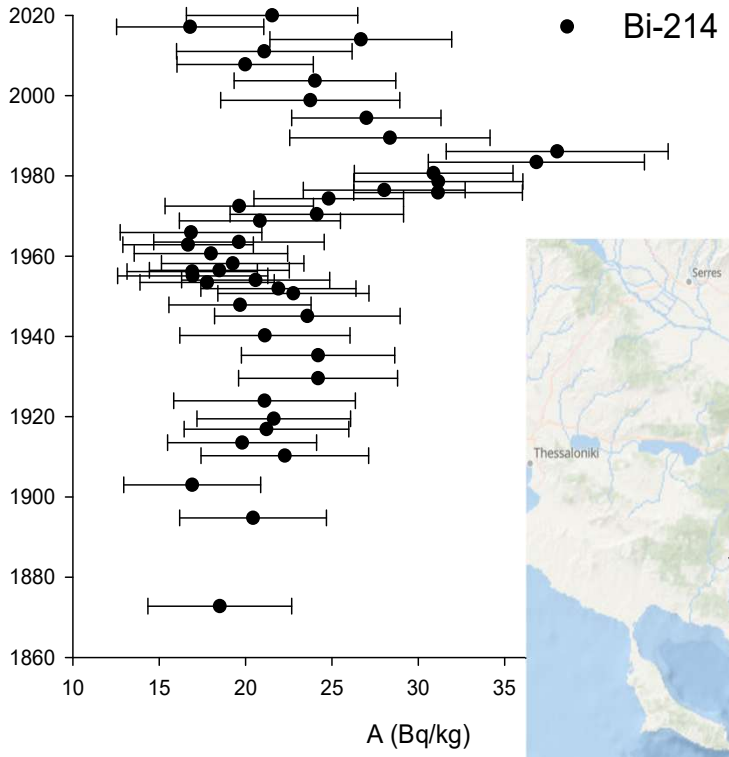
Cretan

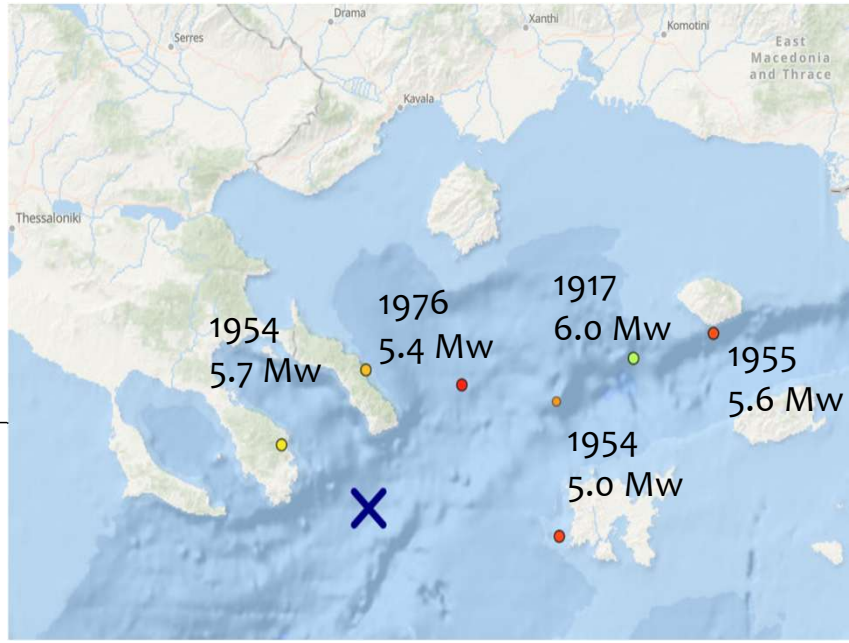


The CRS model assumes a variable $^{210}Pb_{ex}$ activity. This condition may not be applicable

Results CRS/PF - Athos Basin

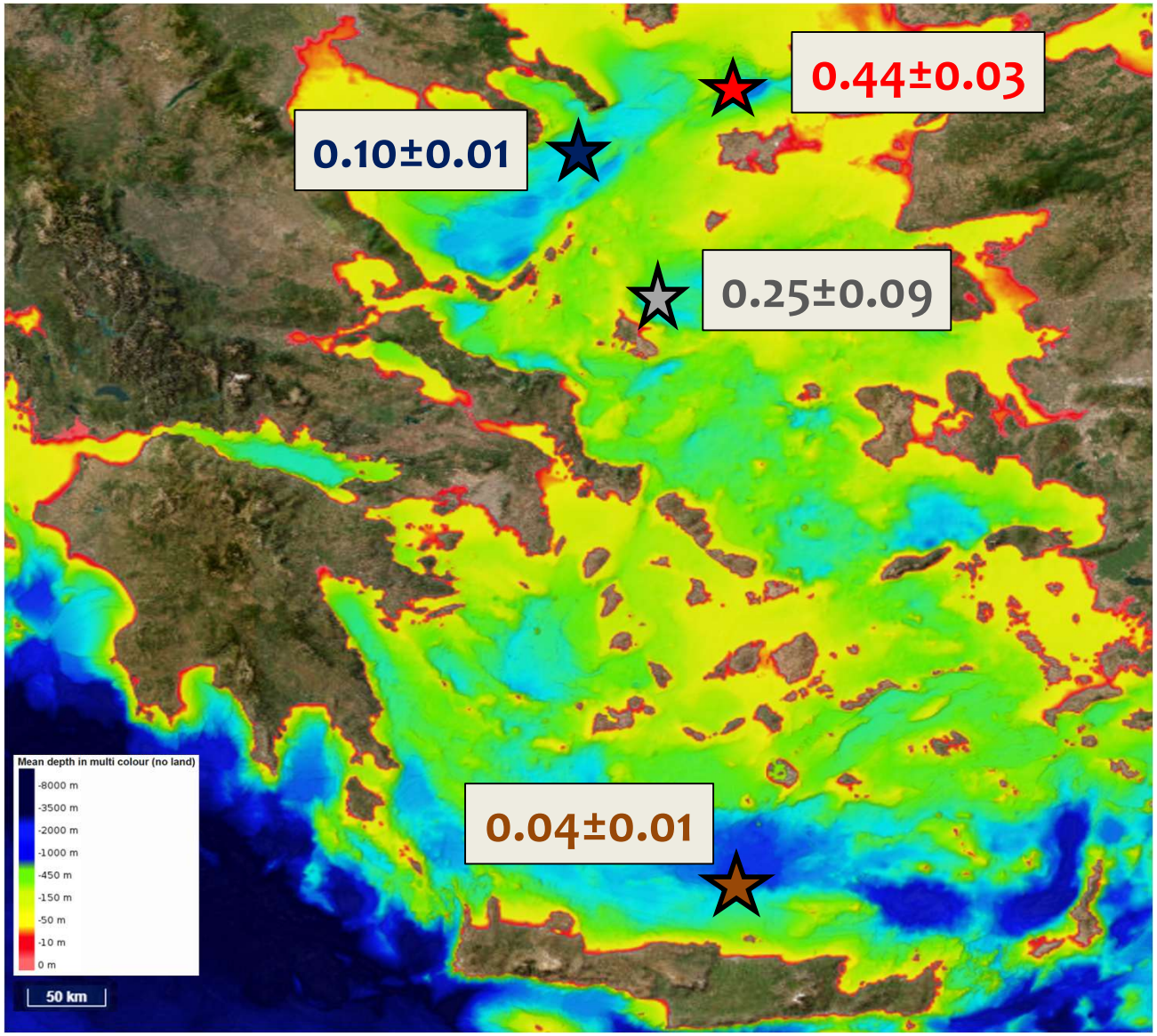






- 2020-1990: same SAR as CF:CS model
- Elevated SAR and A values observed at depths of 7, 12–14 and 23 cm may be associated with historic seismic events that occurred in 1976, 1953–1956 and 1917, respectively

Mean SAR in the last 34 years (after Chernobyl)



★ **Lemnos basin**
1550 m

★ **Athos basin**
1180 m

★ **Skyros basin**
1020 m

★ **Cretan basin**
1500 m

Conclusions

- The application of several ^{210}Pb dating models revealed differences in sedimentation histories among the four deep Aegean basins
- Model agreement in specific intervals suggests relatively stable depositional conditions (Lemnos, Skyros), while model divergence reflects temporal changes in sedimentation dynamics (Athos, Cretan)
- The highest recent SAR were observed in the Lemnos basin, whereas the lowest were recorded in the North Cretan basin. The ratio of SAR between two basins is one order of magnitude
- CRS/PF models identified potential seismic events during the last century in the Athos basin
- Age models (for selected sediment layers) were independently validated using the ^{137}Cs dating method

Perspectives

- Applying additional radiodating methods (with independent variability of all assocciated parameters) to improve chronological reconstructions in basins affected by geological activity/events (Athos, Cretan)
- Conducting XRF measurements to investigate sediment minerology associated with potential deposition events in the sediment core
- Assessing the influence of climatic, oceanographic and seismic processes on sediment accumulation patterns across the Aegean Sea
- Studying additional deep basins in order to assess the full range of SAR variability in the Aegean Sea (Myrtoo, Ikaria)

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Thank you
for your attention!

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