Tehran Convention

Iranian National Institute for Oceanography and Atmospheric Science (INIOAS)

Evidences of the so-called 4.2 climate event observed in the cores collected from the southern Caspian Basin

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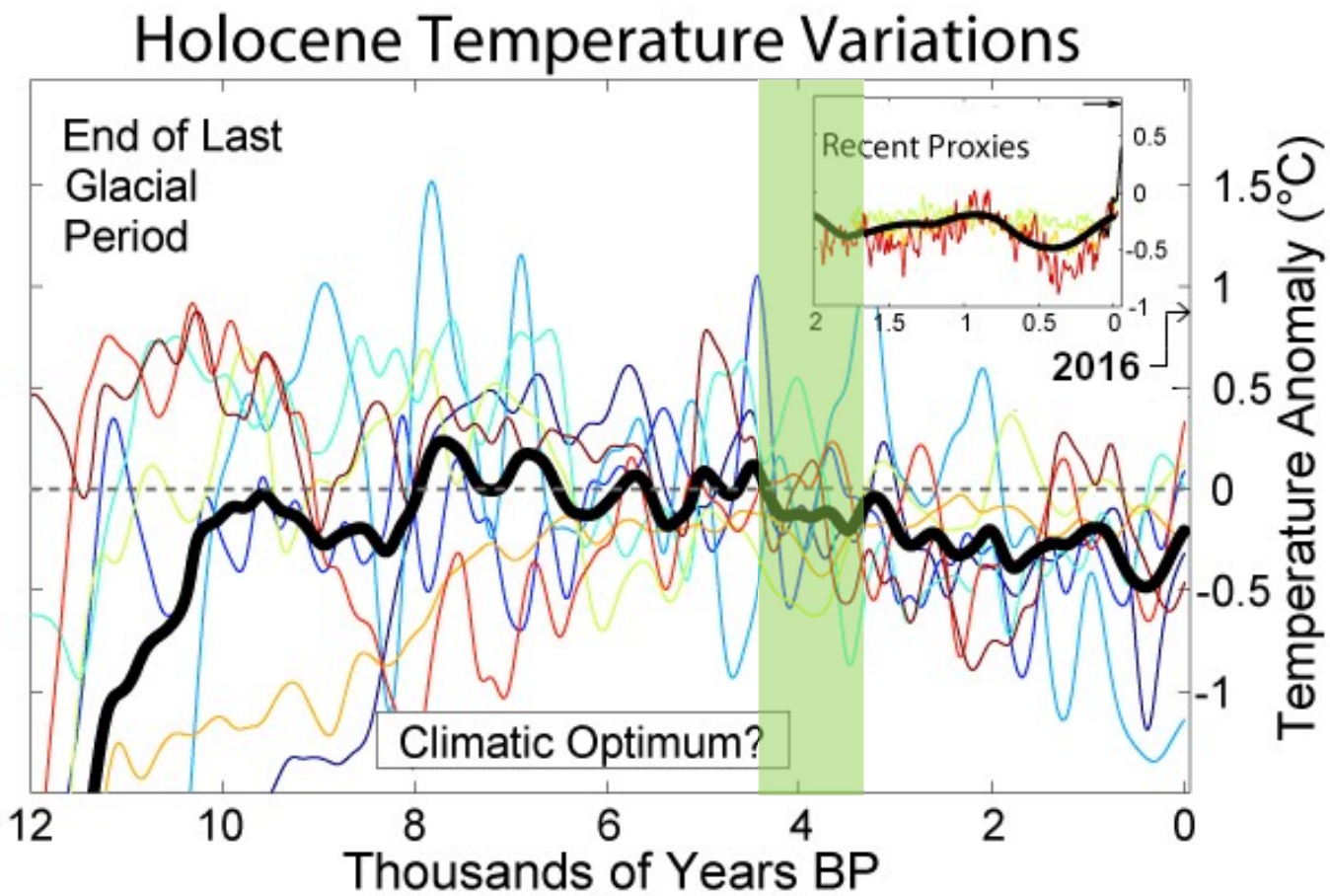
Introduction

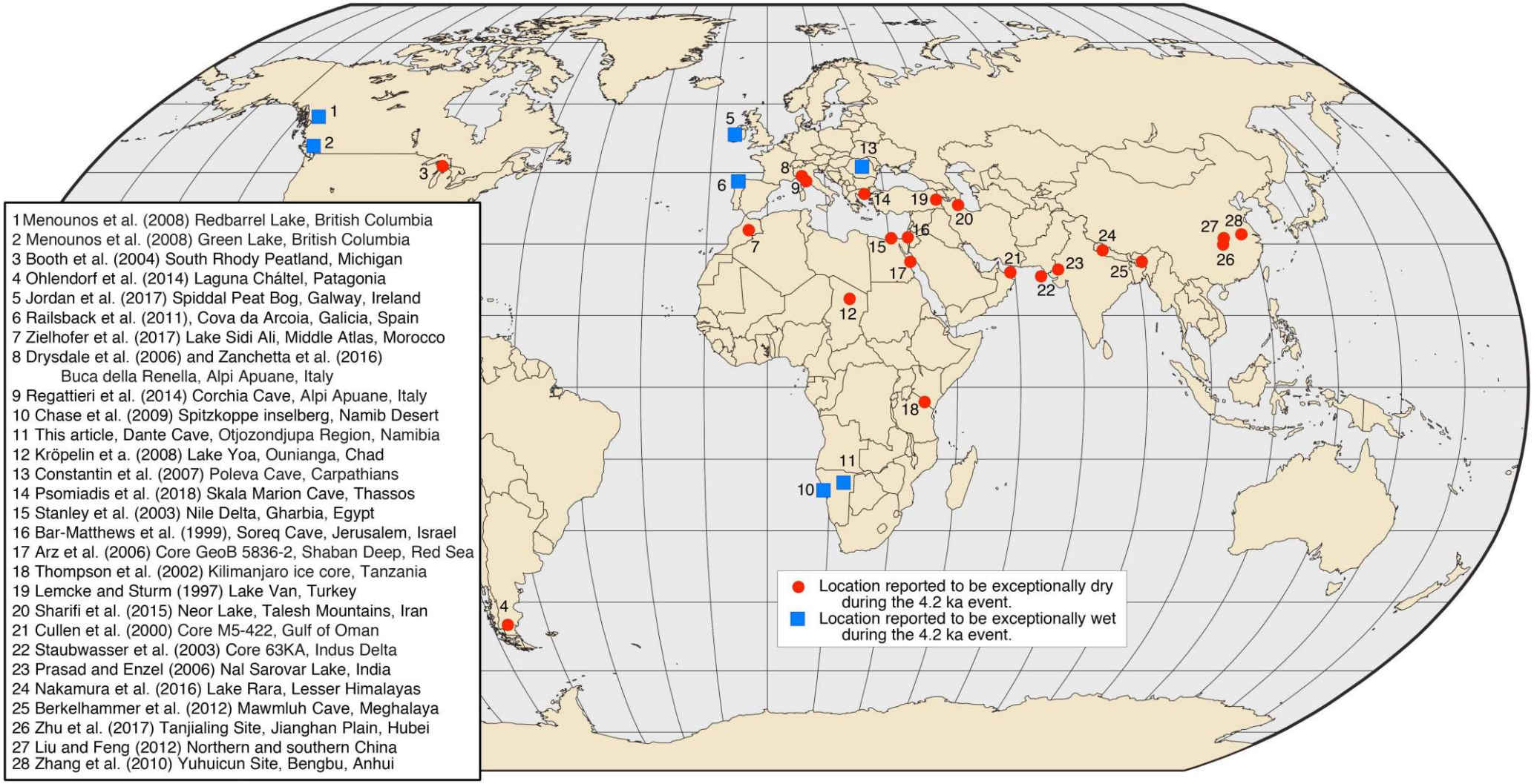
- Studding on past climate events can help us to better understand the undergoing changes in climate.
- One of the interesting worldwide climatic changes is called "4.2 event" that has been reported in the Mid-Holocene.

This event happened around 4200 cal. yr BP that is used as formal boundary between Middle and Late Holocene.
It was **a phase of intense aridity associated with cold weather.**



Introduction:

distribution



Railsback et al., 2017

Introduction:

effects

- This climatic event was associated with cultural transformation in the human societies of the old world.
- There is an idea that this climatic event played an important role in the "collapse" of major ancient civilizations and this idea supports by increasing number of data:

  - the collapse of the Old Kingdom in Egypt [Gibbons, 1993]
  - the collapse of the Akkadian Empire in Mesopotamia (Iran, Iraq and Syria). [Gibbons, 1993]
  - the collapse of the Liangzhu culture in the lower Yangtze River area (China) [Li et al., 2018]
  - the collapse of the Indus Valley Civilisation. [Staubwasser et al., 2003]
  - the migration of Indo-European-speaking people into India. [Kochhar, 2017]

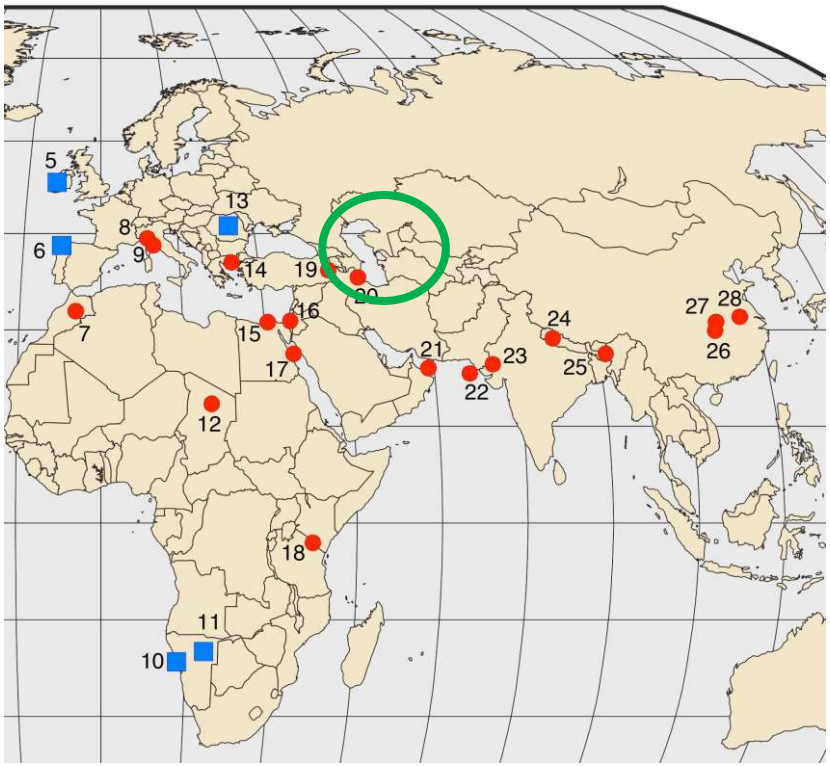
Goddess Ishtar on an Akkadian seal
2350–2150 BC

Introduction:

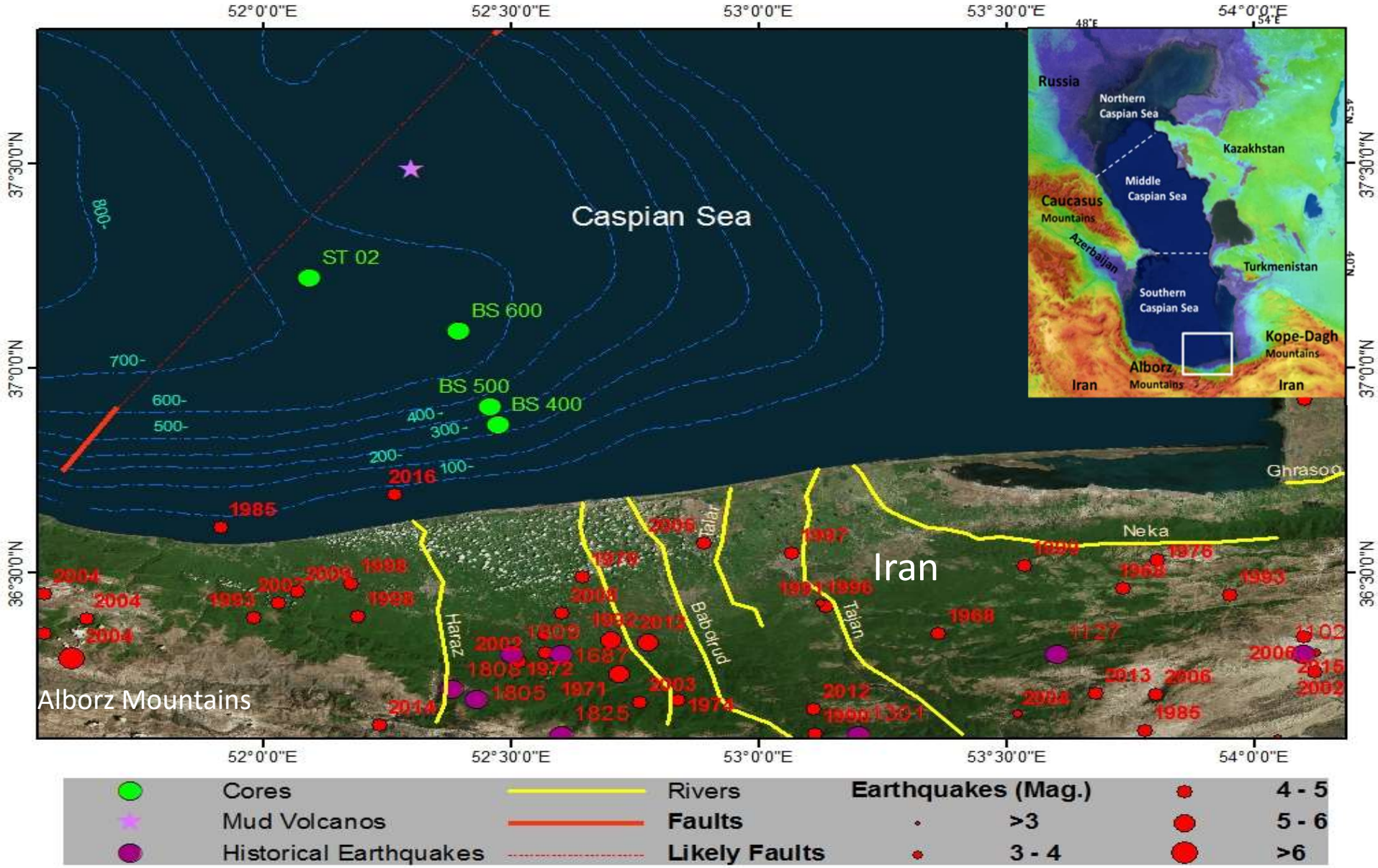
Aim of the Study

- In spite of many evidences reported of this event within the low latitudes, rarely reports in literature can be fined for the high latitudes and there is no reported evidence in the Caspian Basin.

- In this paper, the observations on the sediment cores collected in the southern Caspian Basin were discussed that can be considered as evidences for the climatic changes occurred at around 4 ka.



Study area


52°0'0"E
52°30'0"E
53°0'0"E
53°30'0"E
54°0'0"E
37°30'0"N
37°0'0"N
36°30'0"N
Caspian Sea
ST 02
BS 600
BS 500
BS 400
800-
700-
600-
500-
400-
300-
200-
100-
2016
1985
Ghrasoo
Neka
Iran
Alborz Mountains
Haraz
Babrud
Talar
Tajan
Russia
Northern Caspian Sea
Kazakhstan
Middle Caspian Sea
Caucasus Mountains
Azerbaijan
Turkmenistan
Southern Caspian Sea
Kope-Dagh Mountains
Alborz Mountains
Iran
Cores
Mud Volcanos
Historical Earthquakes
Rivers
Faults
Likely Faults
Earthquakes (Mag.)
>3
3 - 4
4 - 5
5 - 6
>6

Marital and Methods

1. Three short sediment cores were retrieved using a gravity corer

2. susceptibility (MS) of the intact sediment cores were measured at the INIOAS laboratory with 1 cm increment.

3. Cores were split using a hand-made core splitter.

Marital and Methods

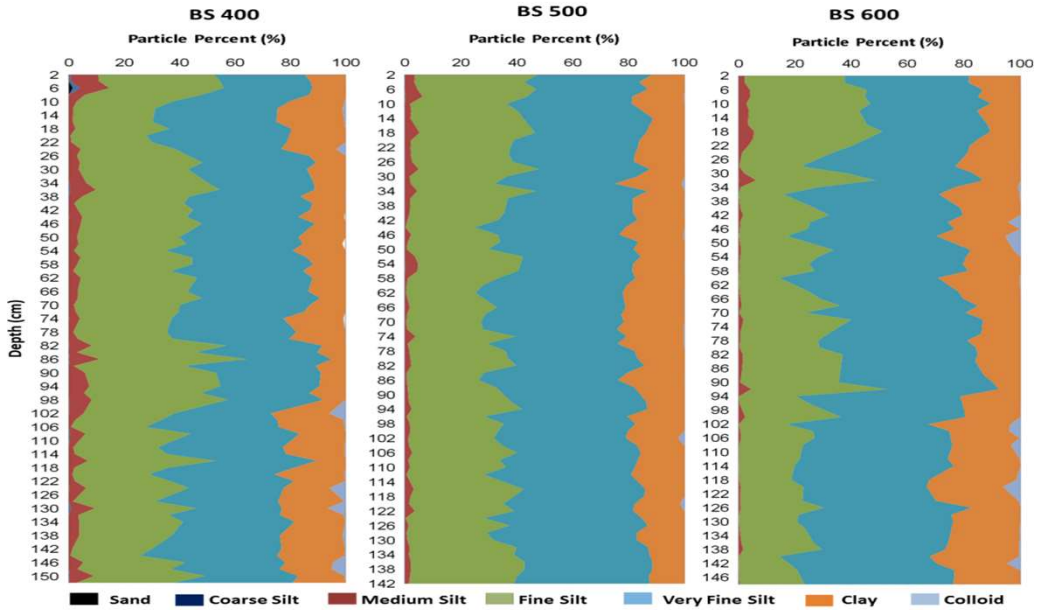
3. Half of the cores were sent to CEREGE laboratory, Aix-Marseille University, France, for continuous XRF measurements. Before scanning, the cores were radiographed for overall density and structure.

4. The other half of the cores were subsampled every 2 cm for a total of 201 samples which were treated to measure grain size, calcium carbonate, and organic matter (OM) contents at the INIOAS laboratory.

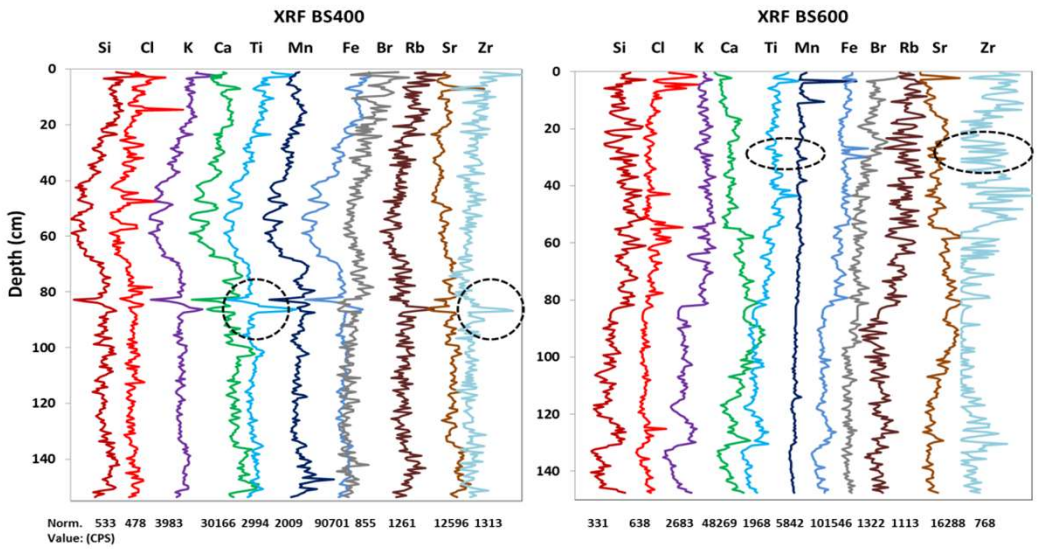
5. Bulk samples taken from different horizons of the cores were dated in Poznan Radiocarbon Laboratory by ^{14}C method.

Results

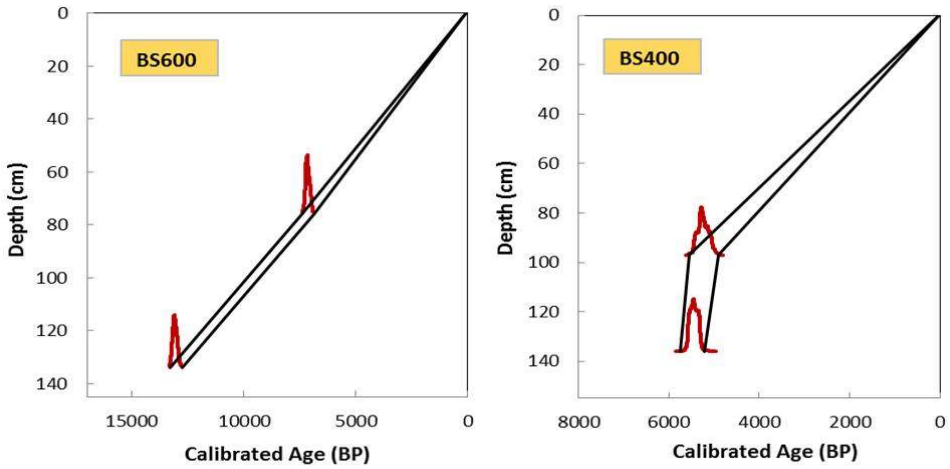
- Based on granulometric analysis, almost all sediments fall within the range of silt to clay. Sand and coarse silt particles are detected just in a some horizons.
- Based on the calibrated ages, core BS400 hardly covers Middle Holocene, while BS600 could go back to Younger Dryas and even older.
- According to the XRF analysis, the most considerable anomaly is the variation of the elements' concentrations in the depth of 80-90 cm in core BS400 which will be discussed later



Grain size distributions of the sediments



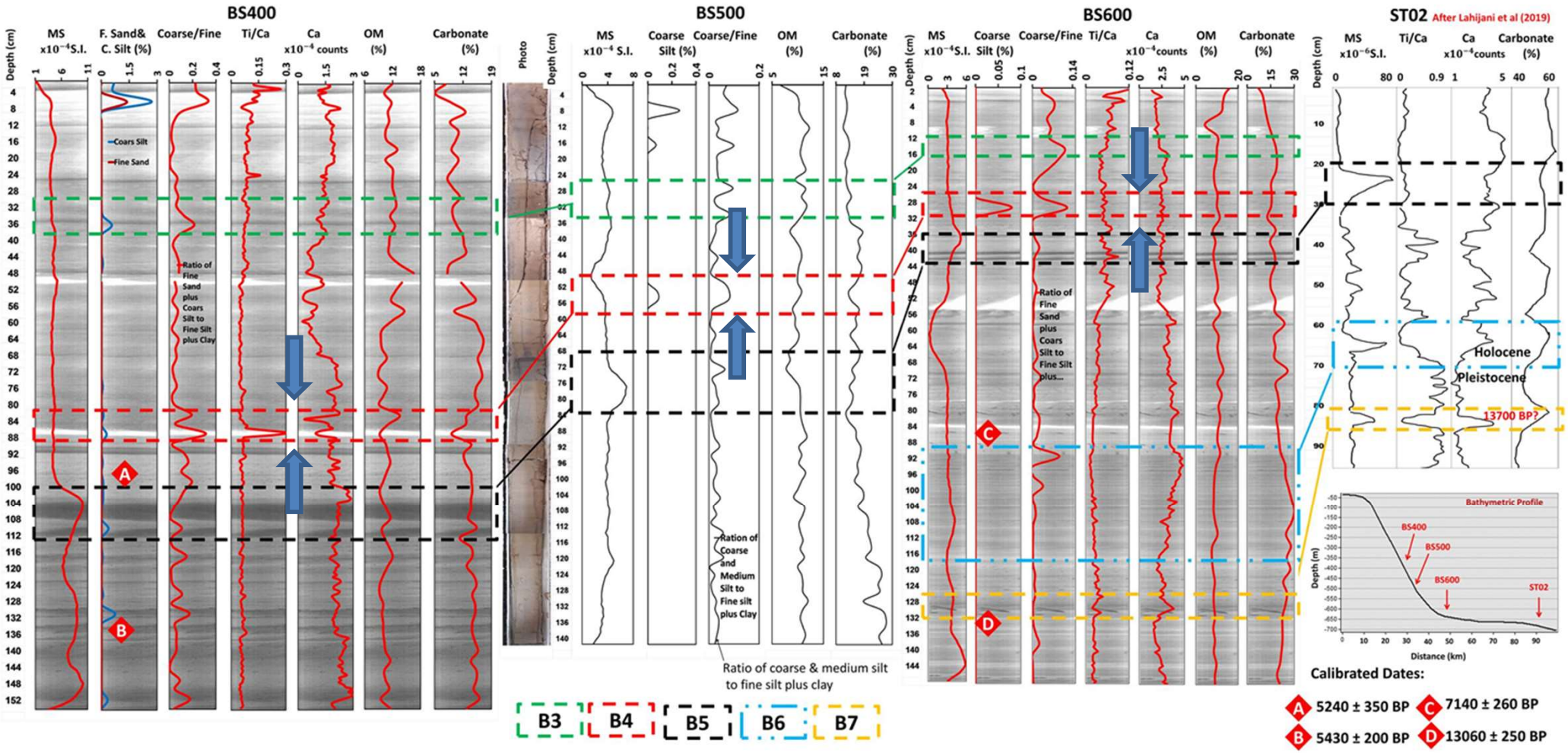
The results of XRF core scanning for the cores



Age-depth model output for the cores

Core Correlation

Based on the variation of different sedimentological and geochemical parameters and also considering the calibrated ages, anomalous sedimentary facies and beds in the cores were identified and correlated.



The anomalous bed of 4.2 event

- An anomalous bed was identified in cores BS400, BS500 and BS600 that characterized mainly by coarser sediments. In spite of identification of this bed in all the cores, the evidences that show this bed probably can be related to the 4.2 climatic event are observed on the log of BS400 due to the thickness of the bed that is much more than it on two other cores. So, here, we discuss only on the observation and evidences of BS400.

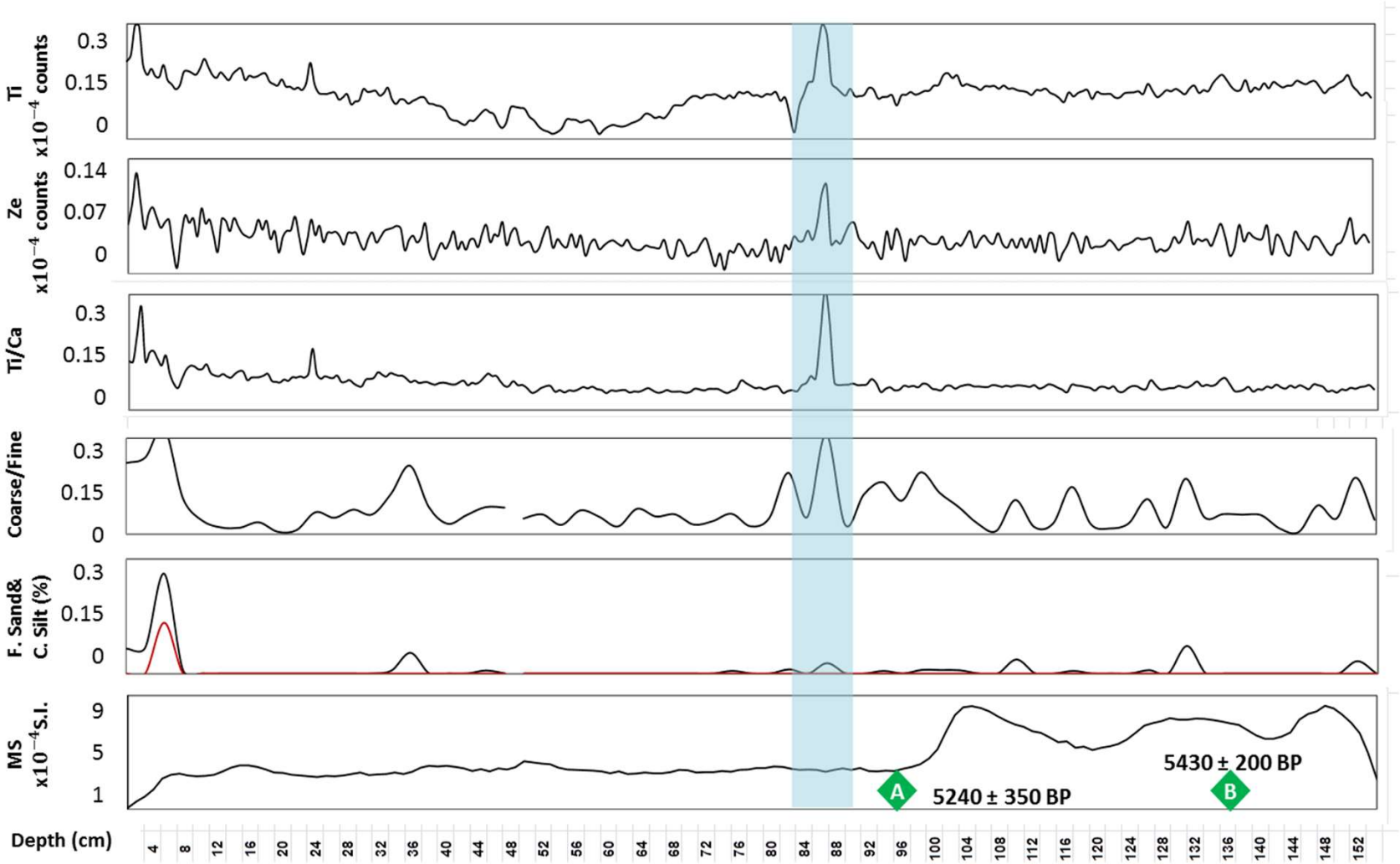
- According to the radiocarbon dating, non-calibrated ages for the samples taken at the depths of 97 and 136 cm of core BS400 were determined 4950 ± 40 BP and 5110 ± 40 BP, respectively. The radiocarbon ages were calibrated to calendar years using the CALIB Rev 6.1.1 software.
- Core BS400 hardly covers Middle Holocene, while BS600 could go back to Younger Dryas and even older.

- Based on age-depth model of core BS400, the anomalous bed of interest was deposited between 4430±350 to 4860±350 BP and associates with significantly higher values of Zr and Ti.

Core logs of BS400

The discussed event of 4.2 is characterized by dry and cool climatic conditions. The high values of Zr and Ti also represent rather physical weathering and cold climate conditions. Therefore, it seems that the discussed bed may be linked to the climatic event of 4.2.

Green diamonds show the depth where the samples were selected for chronology. The Calibrated age of samples are presented close to diamonds.

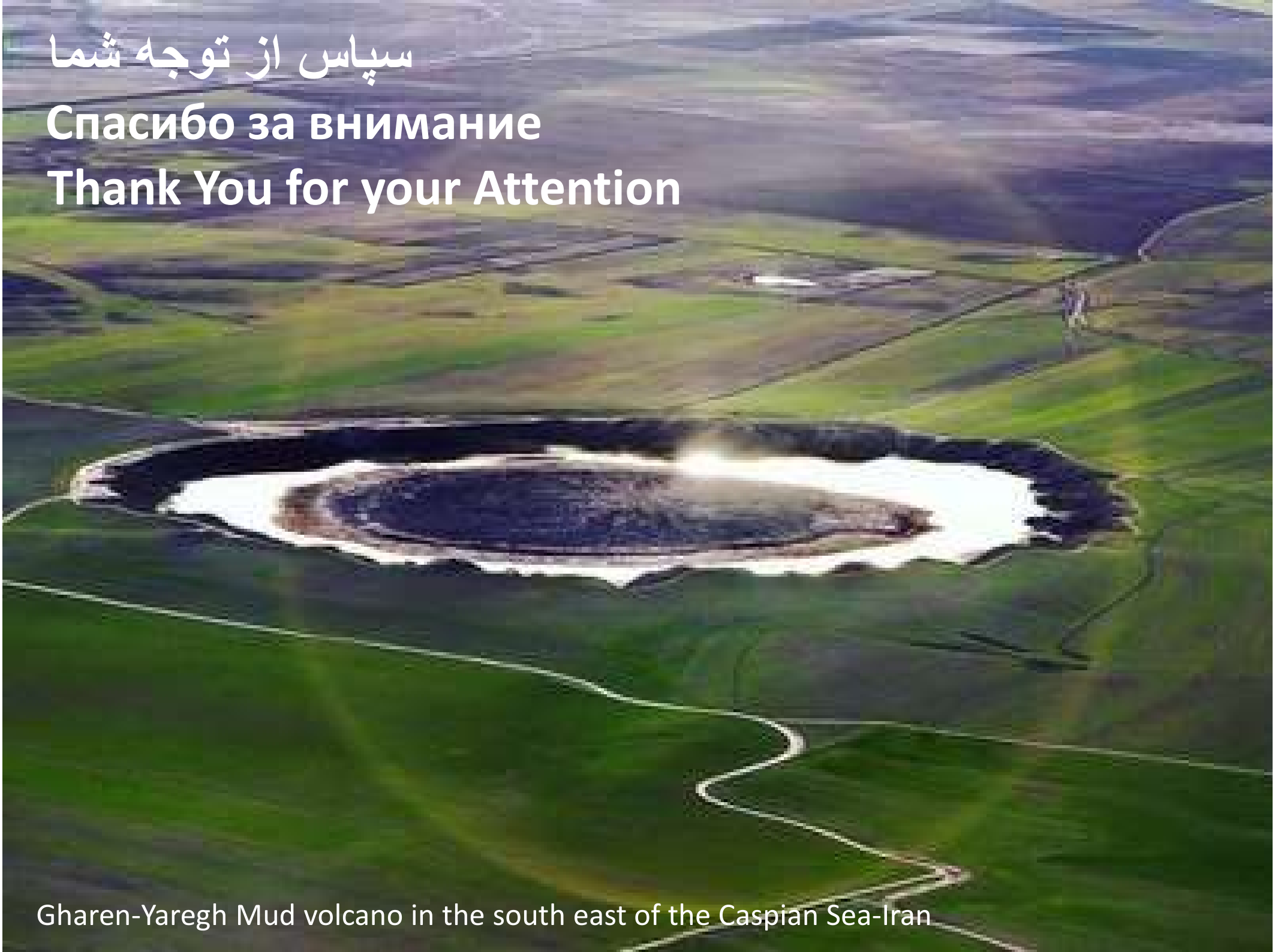


Conclusion

- Three short cores collected from southern Caspian Basin were tested by different sedimentary and geochemically methods and analyzed to identify pale-events.
- For the first time in the Caspian Basin, sedimentary and geochemically anomalies were observed on a bed aged between 4430±350 to 4860±350 BP that can be considered as traces of the climatic event so-caled “4.2 event”.
- This results show that the high latitudes also were affected by the event.

- Considering these facts that:
  - first: the climatic events like 4.2 have been associated with social and political revolutions that affect all around the word
  - second: humankind is facing with a global climate change

it can be claimed that the current changes in climate will probably be followed by social and political changes affecting north latitudes.



Gharen-Yaregh Mud volcano in the south east of the Caspian Sea-Iran