Refining chronologies by dating pollen concentrates – new approach of separating pollen using flow cytometry

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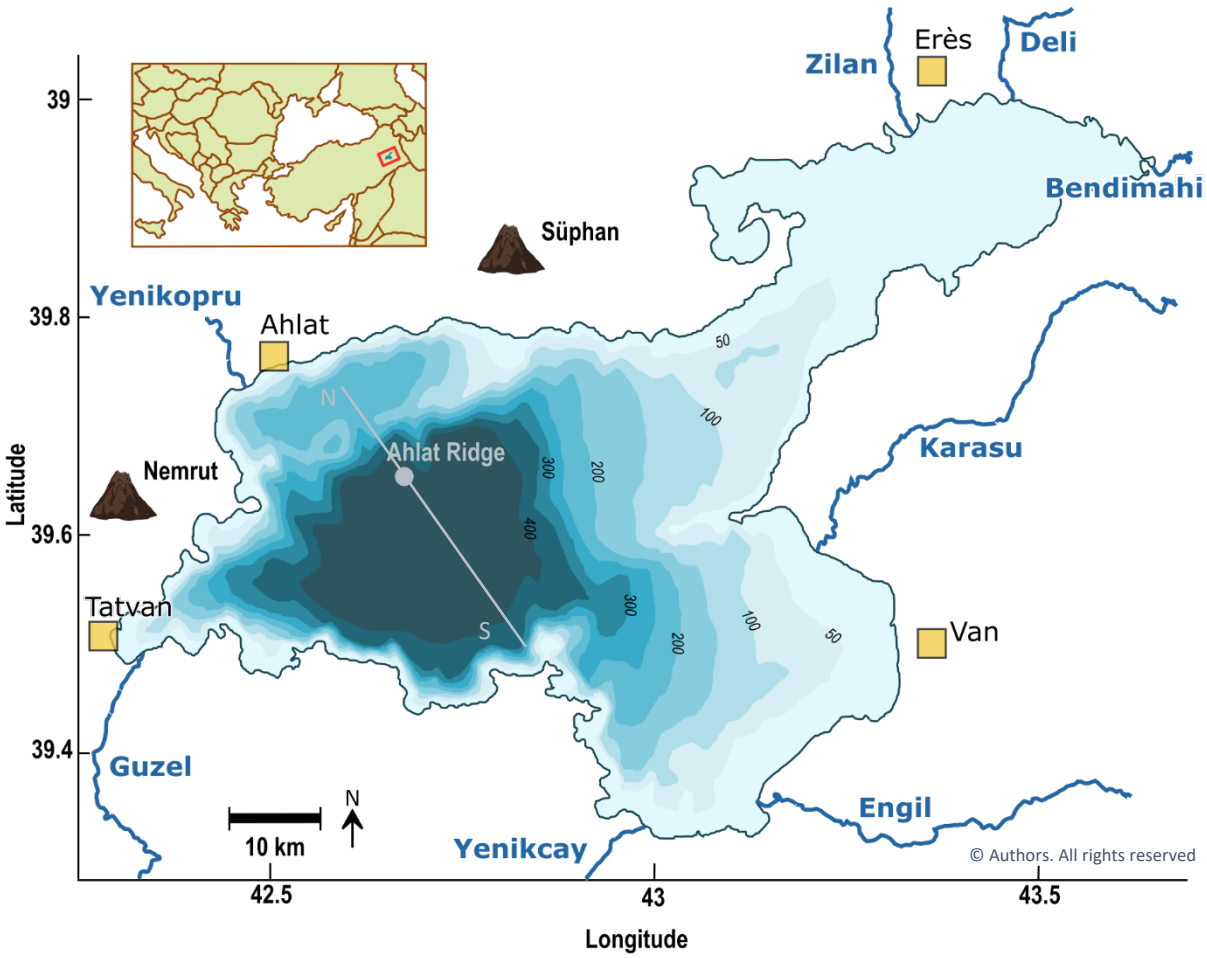
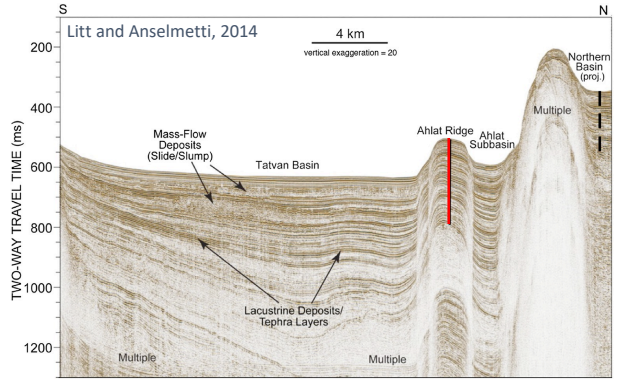
PALEOVAN - Project at Lake Van



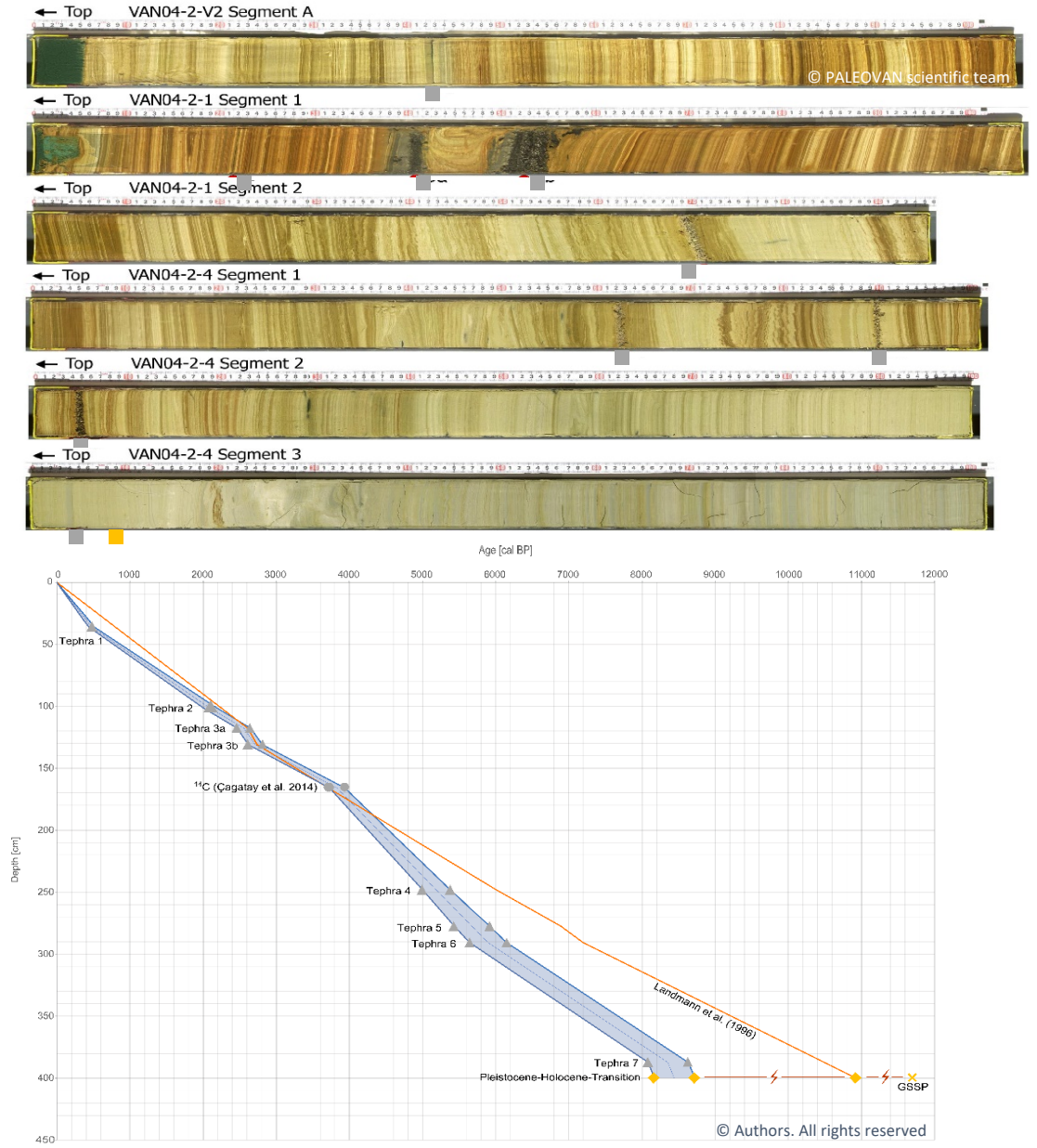
- ICDP funded deep drilling project at Lake Van in Eastern Anatolia (2004 and 2010)
- Analysis and reconstruction of the Quaternary climate in the Near East
- Drilling at Ahlat Ridge carried out sedimentary succession of ca. **220 m**, spanning over **600 000 years**



- North-south trending **seismic profile** crossing main **Tatvan Basin** and **Ahlat Ridge** (PALEOVAN location - **375 mbsf**)

Lake Van - Varvechronology

- Interglacial layers are **annually laminated**
- Varve counting provides possibility to create high resolution chronology
- Maximum age for the Holocene-Pleistocene-Transition is **8719 vy BP** (**yellow**)
- **Discrepancy** of ca. 3000 years to GSSP
- Seven volcanic ash layers (**gray**) allow the correlation to other sedimentary profiles in Lake Van
- Comparison to existing varve chronology by *Landmann et al. (1996)* (**orange**) shows missing varves/erroneous counting in lower part
- **^{14}C measurements above and below reference layers (tephra) to validate varve chronology**



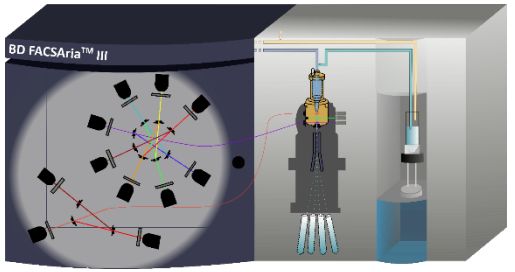
From Sediment to Pollen Concentrate

Chemical Pretreatment

- Initial volume of **15-45 cm³**, depending on pollen conc.
- Use of **HCl;** removal of carbonates
- Coarse sieving (**53 µm** mesh width)
- Use of **HF;** dissolution of silicates
- Ultrasonic sieving (**10 µm**)

Flow Cytometry

- Cytometric analysis using **flow cytometry** *(GFZ Potsdam)*
- Laser based **multiparameter analysis**
- Separation based on fluorescence activated cell sorting (**FACS**)

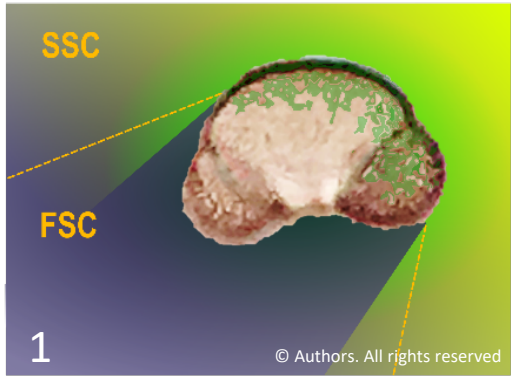


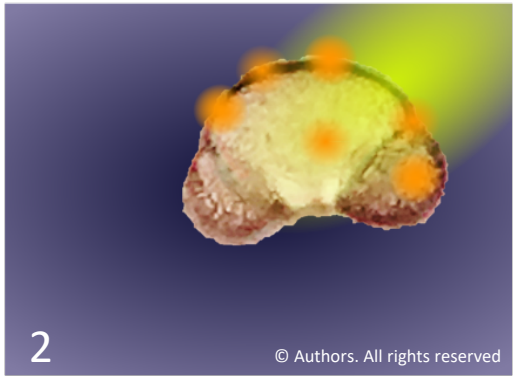
AMS Dating

- AMS dating using gas ion source *(ETH Zürich)*

Flow Cytometry

Application to **analyze**, **identify** and **isolate** populations of heterogeneous samples according to optical properties

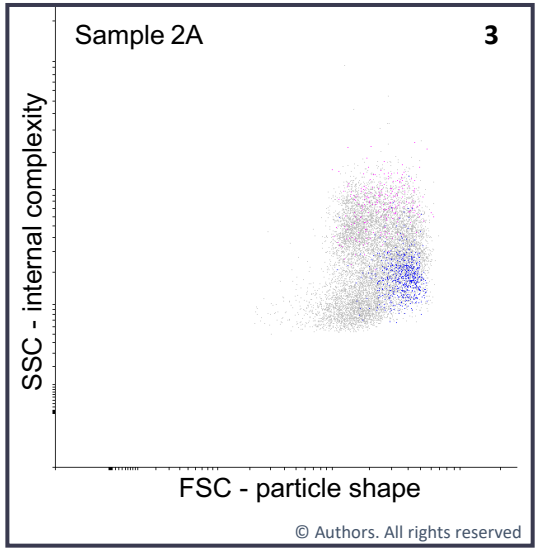


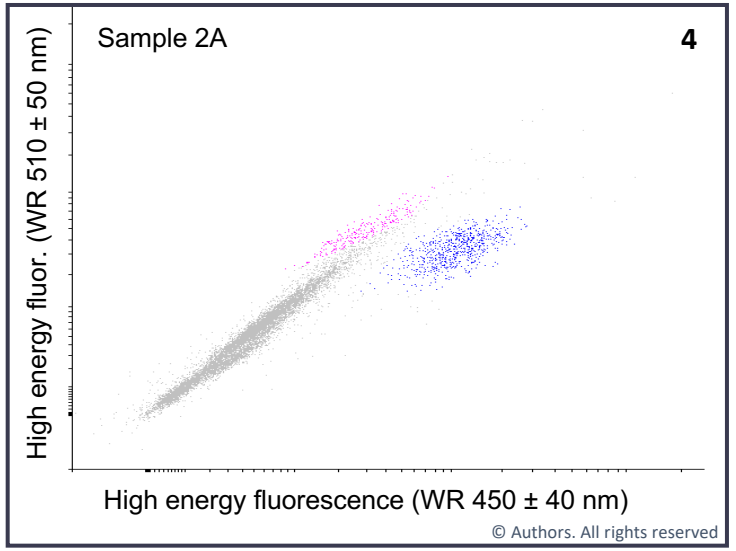


1. Measuring intensity of refracted light on surface structure (**forward scatter** FSC and **side scatter** SSC)
   - ➢ Indicator for size, shape and internal complexity of grains
2. Additionally measuring spectra and intensity of **auto fluorescence signals** of particles generated by various lasers

Scatter plots (each dot represents 1 particle) for identification of subpopulations (**cytometric analysis**)

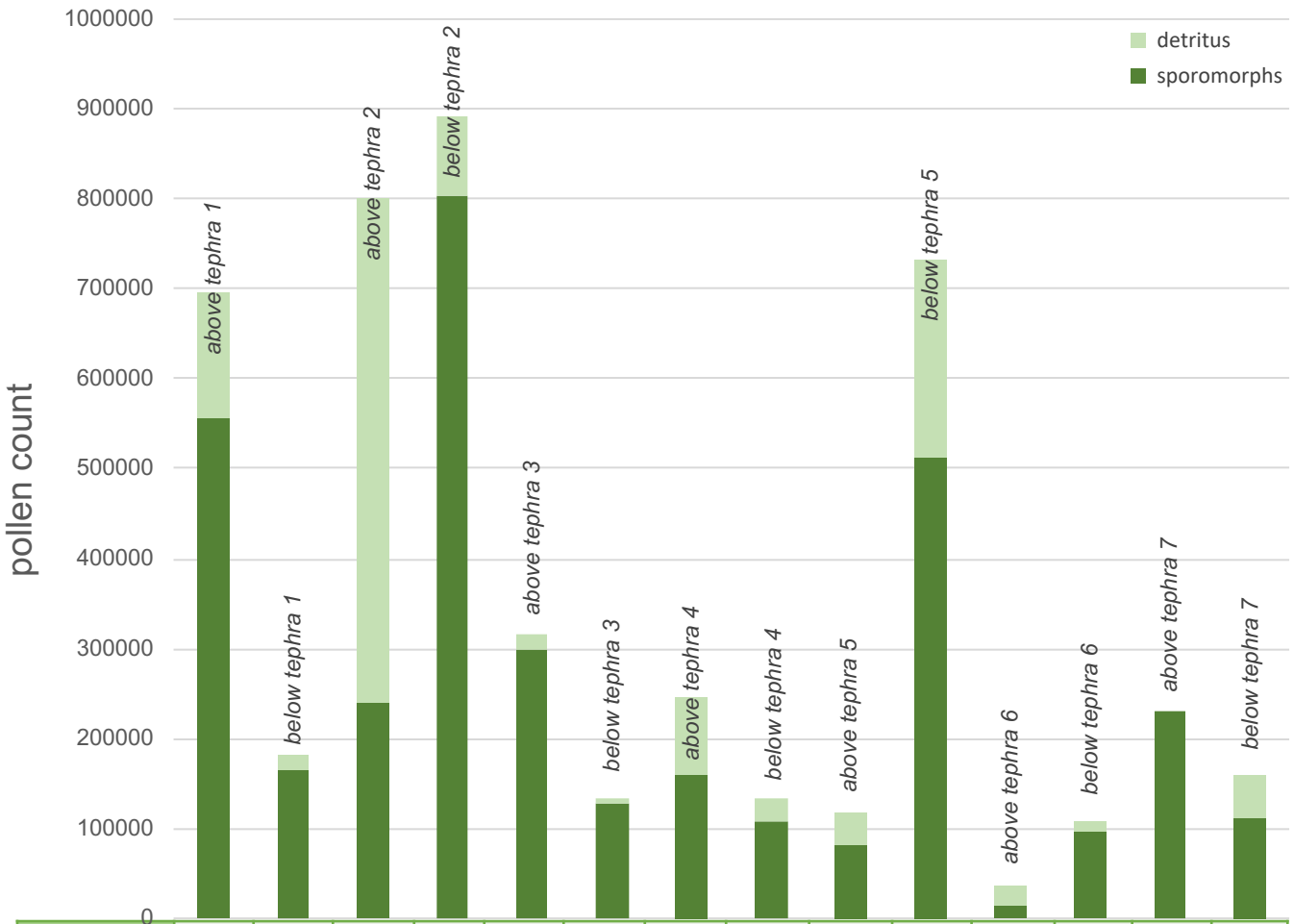
3. Morphological properties: No differentiation between **sporomorphs** (**pink**, **blue**) and **detritus** (**gray**) possible
4. Fluorescence signal: Separation of distinctive **pollen** (**pink**) and **spores** (**blue**) is now possible





Results – Flow Cytometry

- Cytometric analysis allows **unequivocal identification** of pollen and spores
- Total pollen count varies widely (**40 000 – 900 000 grains**) and is independent of initial volume, sample depth, and sorting strategy
- Ratio of sporomorphs in pollen concentrate is largely **>70%**
  - Some detrital particles with inherent color remain in concentrate after separation
  - But recently developed strategy allows isolation of pollen concentrates with purity **>90%**
- Sample weight (µg C) varies between **13 – 160 µg carbon** and is **suitable for AMS dating**



	above tephra 1	below tephra 1	above tephra 2	below tephra 2	above tephra 3	below tephra 3	above tephra 4	below tephra 4	above tephra 5	below tephra 5	above tephra 6	below tephra 6	above tephra 7	below tephra 7
Pollen count (10^3)	695,7	81,2	800,6	891	315,4	134,4	245,2	133,1	117,7	732,1	35,7	108	230	159
Weight (µg C)	80	20	160	150	60	30	not quantifiable	30	28	140	13	28	50	55

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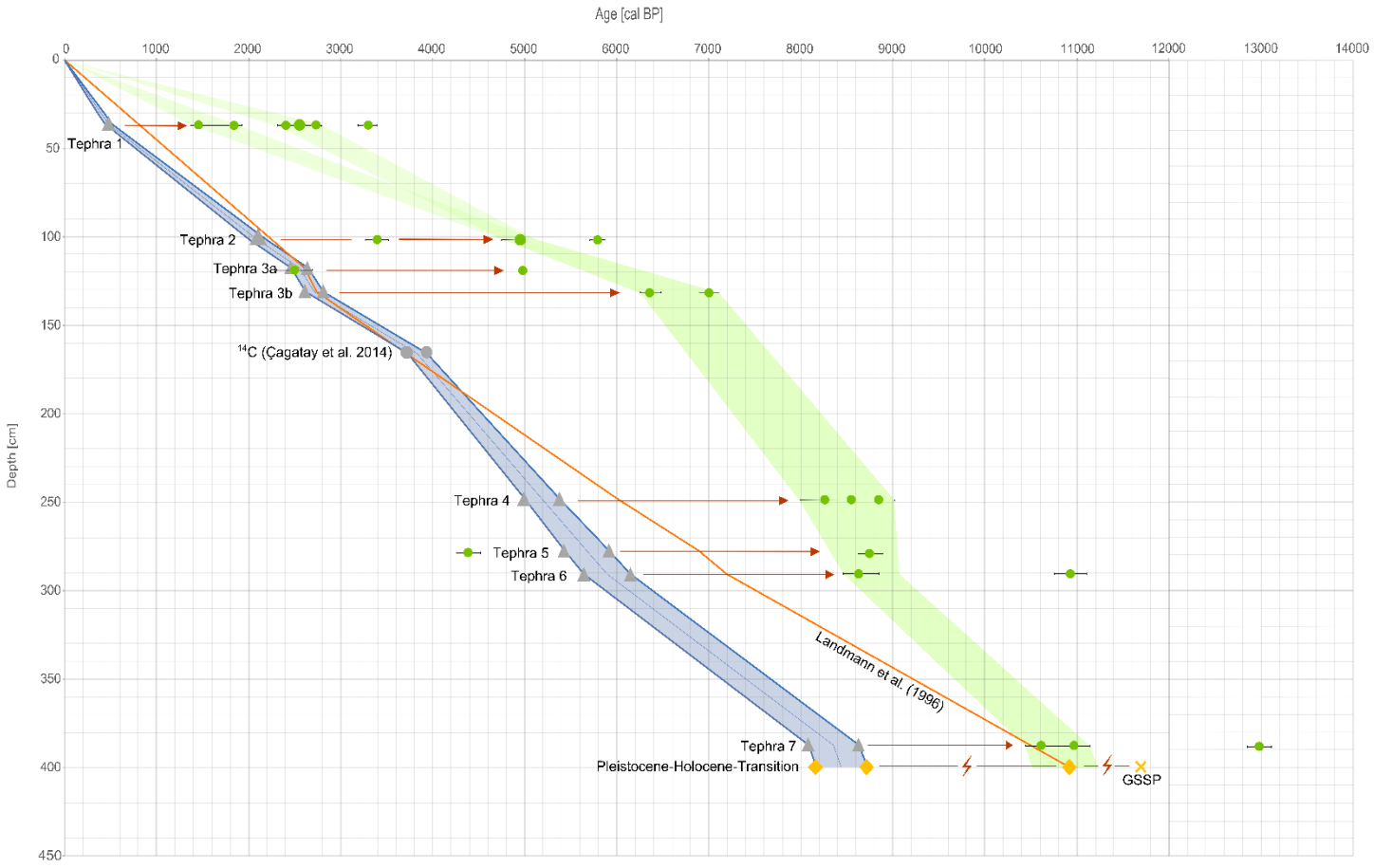
Results – AMS Dating

- ^{14}C ages (green) **older** than varvechronology
- Good agreement in lower part of section
  - **Gap** between varve counting and GSSP for onset of the Holocene can be **closed**
- **Hiatus** in sedimentation above tephra 1
  - **Landslides** due to **ridge position**
- **Statistical errors** increase from ± 100 years in upper part to ± 170 years in lower part
- **Scattering** of all **measurements** varies between 2500 years around tephra 1-3 and 700 years for tephra 5 and 7
- Large uncertainty below **tephra 3**, wide range in pollen ages



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Outlook

It is possible to **generate ^{14}C ages** derived from **pollen concentrates**!

Discrepancies concerning the Holocene chronology of Lake Van **can be solved**.

Still, we need **improvements** in sample preparation to **increase** pollen **yield**, while **minimizing** risk of **contamination**.

Reliable measurements on **old** and **recent carbon** are necessary to exclude the contamination of the flow cytometry itself.

Further **samples between** the **tephra** layers are already taken, which will help do **reduce** the **scattering** of our AMS ages and further **refine** the **Holocene chronology of Lake Van**

Thank you for your interest!

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