ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

GFZ Helmholtz Centre Potsdam

The polygenetic hypothesis of Yedoma origin – comparing grain-size distributions of Alaskan and Siberian Yedoma

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Objectives and backgrounds

Hypothesis of Yedoma genesis

1) alluvial genesis,
2) ice-sheet-dammed basin deposits
3) deltaic formation
4) proluvial and slope deposits
5) marine-estuarine-lagoon formation
6) cryogenic-aeolian deposits
7) nival deposits
8) polygenetic origins.

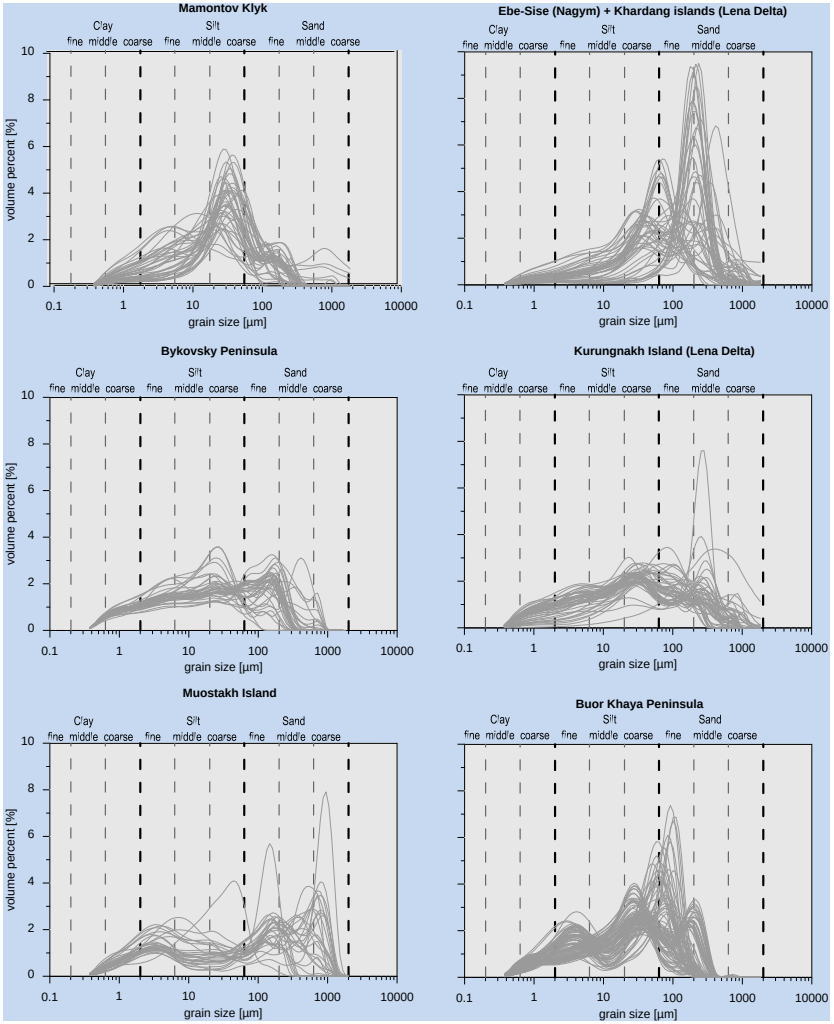
Main goals of this study

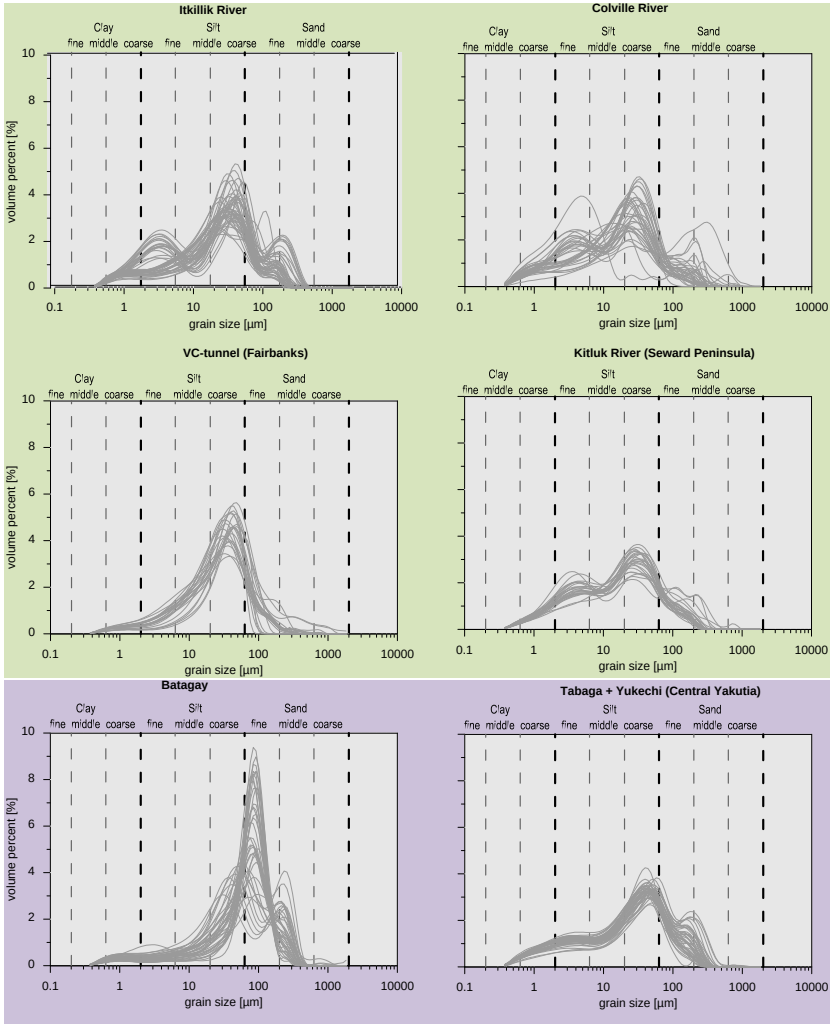
- Identification and interpretation of characteristic patterns in grain-sizes distribution data sets
- find out common features and differences
- Developing a site-specific interpretation of past depositional processes to understand Yedoma formation

Locations of study sites in Siberia and Alaska

Grain size analysis and End-member modelling analysis

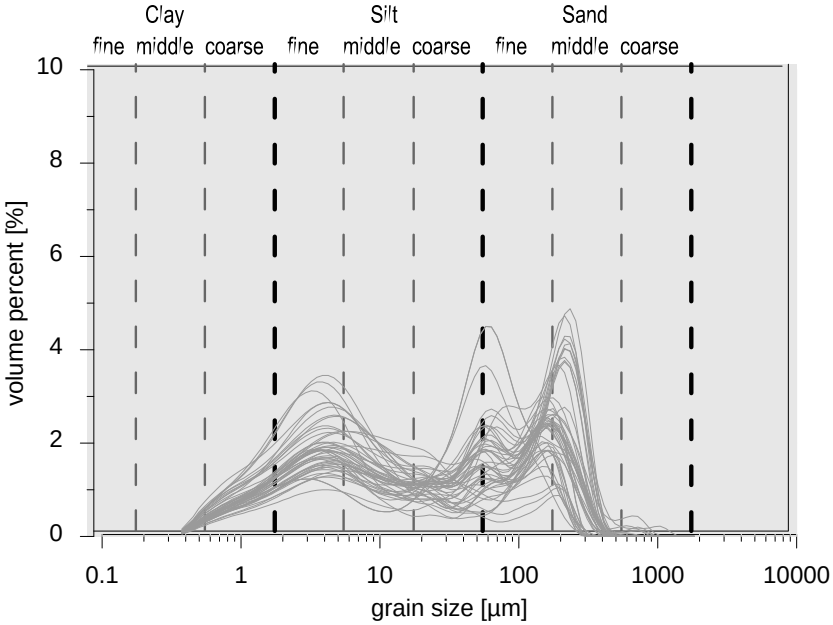
- Laser diffraction particle analyzer (Coulter LS 200) - 92 size channels between 0.375 and 2000 µm
- **780 samples from 17 Yedoma sites** in Alaska and Yakutia studied between 1998 and 2014
- **180 reference samples** from low centered polygons, flood plain deposits and loess deposits
- **End-member modelling analysis** (EMMA) to unmix poly-modal grain-size distributions of each site
- Into characteristic grain-size subpopulations after Dietze et al. (2012)



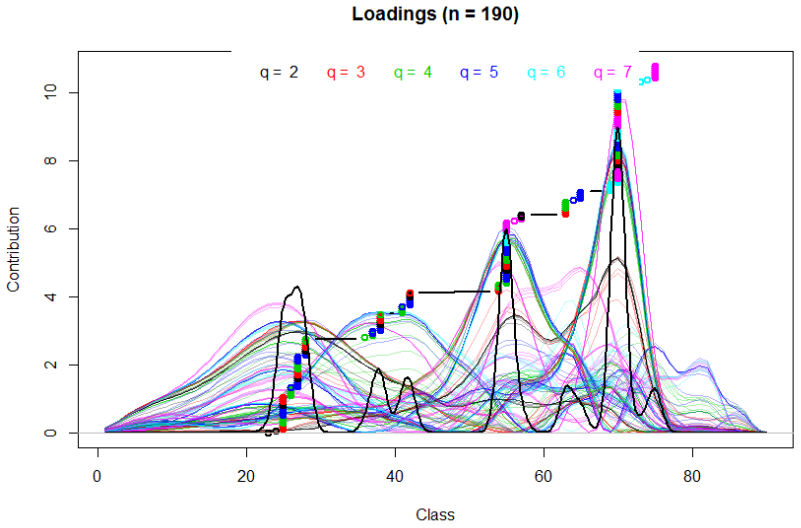


Grain size analysis and End-member modelling analysis (software package EMMAgeo in open source R)

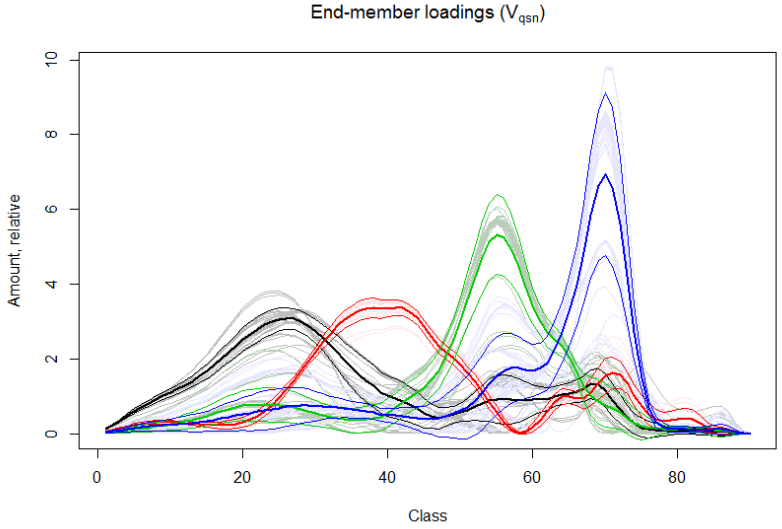
1. Measured grain size distribution



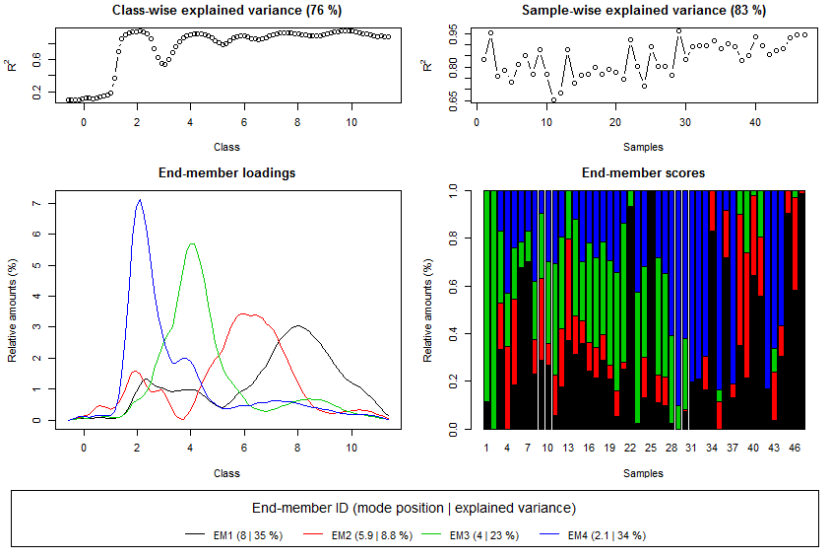
2. Identification of robust endmembers from all similarly likely endmembers (explained variance >50%)



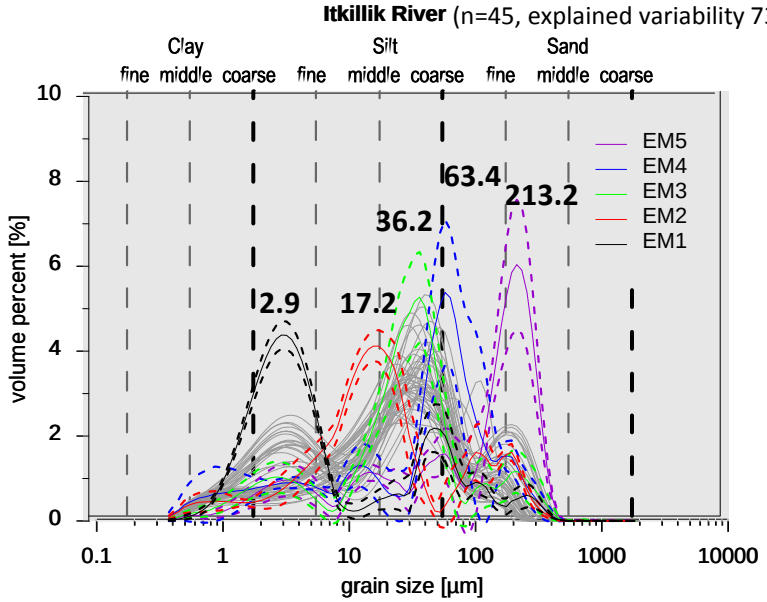
3. Mean loadings and spread of robust endmembers

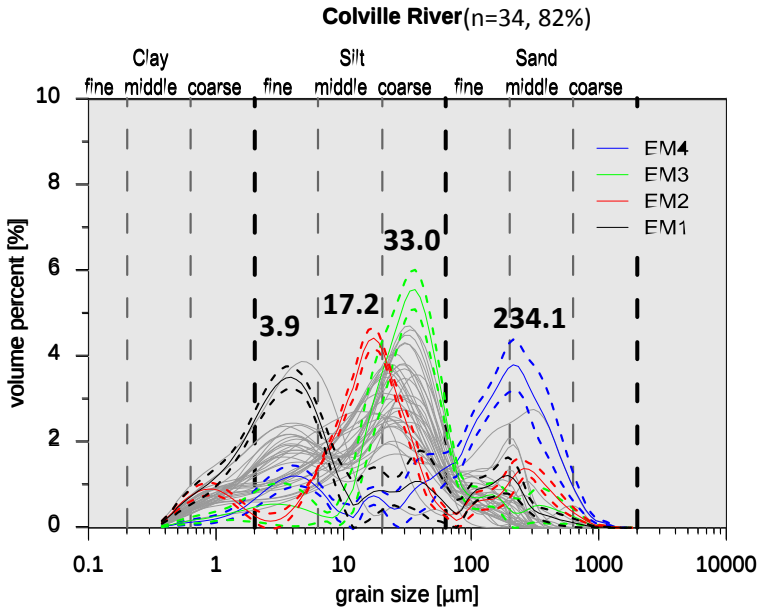


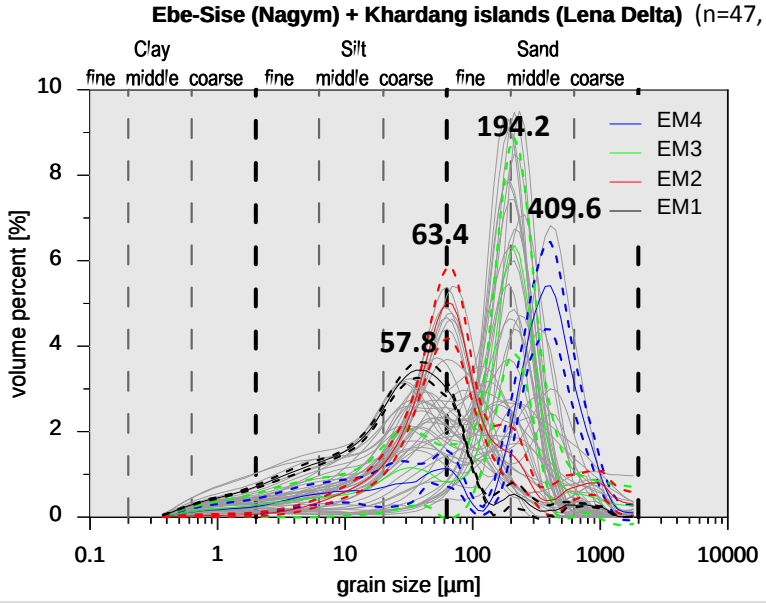
4. Scores of mean robust endmembers and explained variances

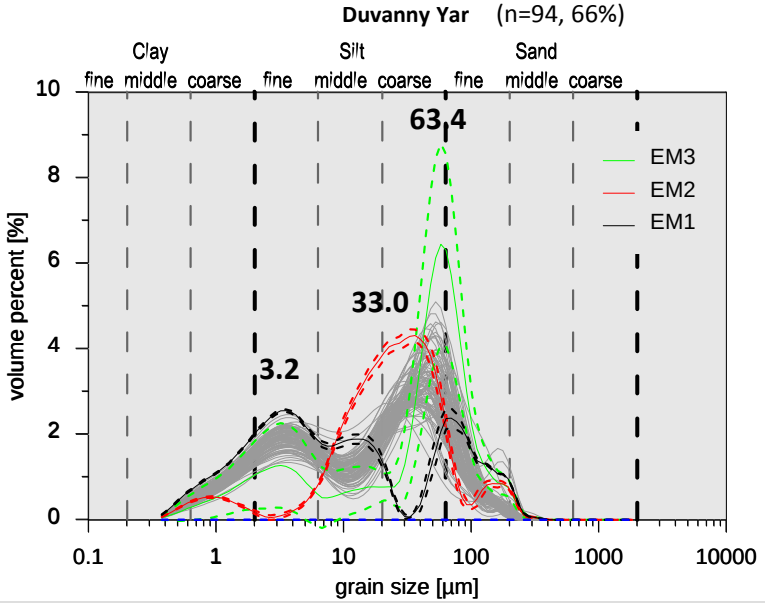


Results of robust end-member modeling (gray curves - original grain-size distributions), end-member loadings (contribution of grain-size classes to each end-member) dashed lines -standard deviation for each end-member)



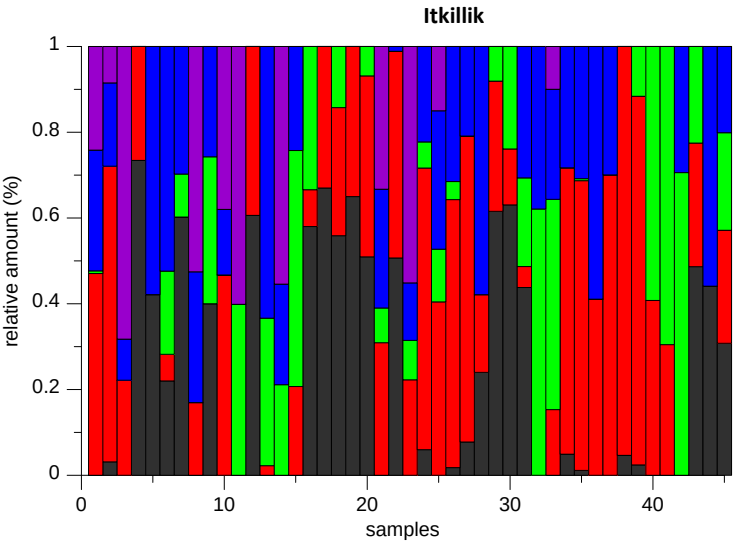


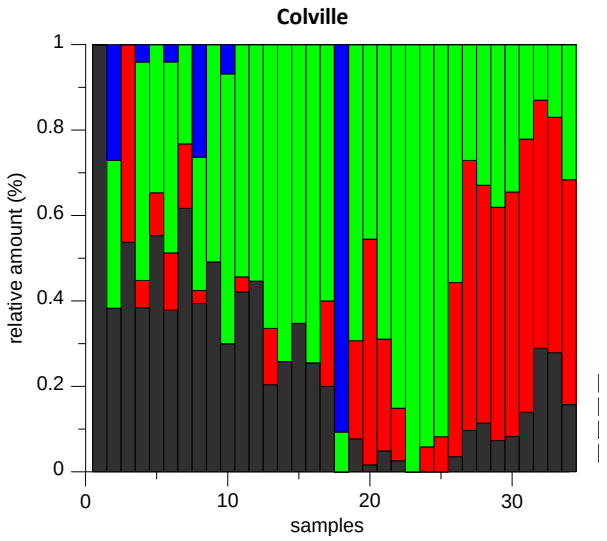


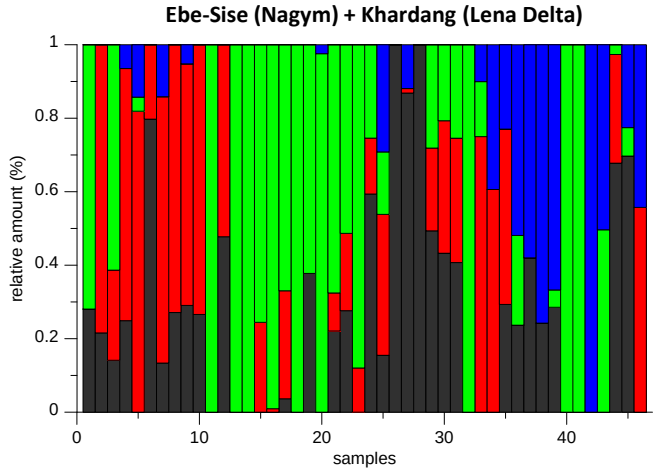


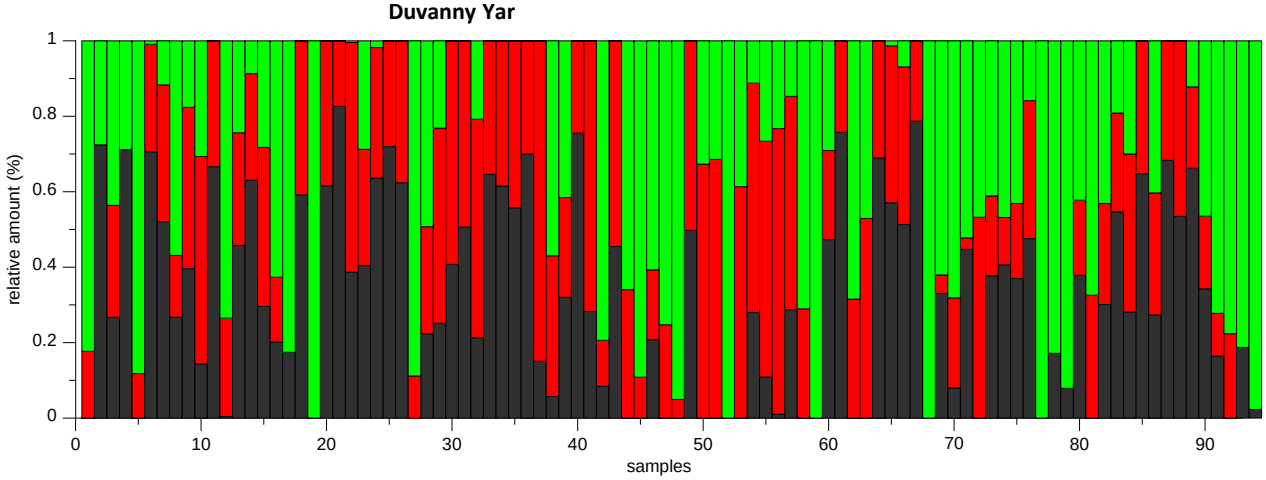
Distribution of robust end-member loadings for each sample

mean scores (i.e. relative contribution of an end-member to each sample)

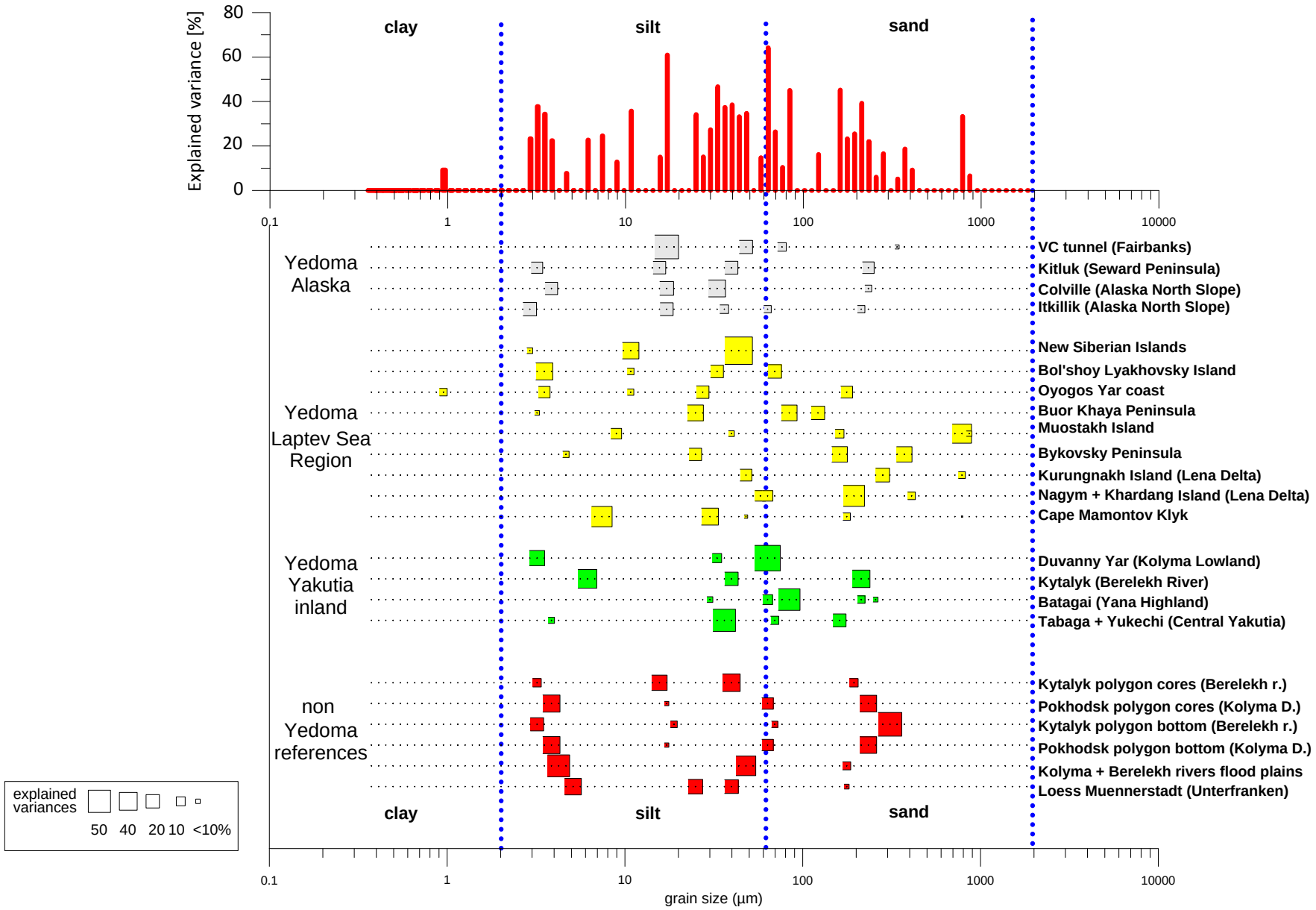




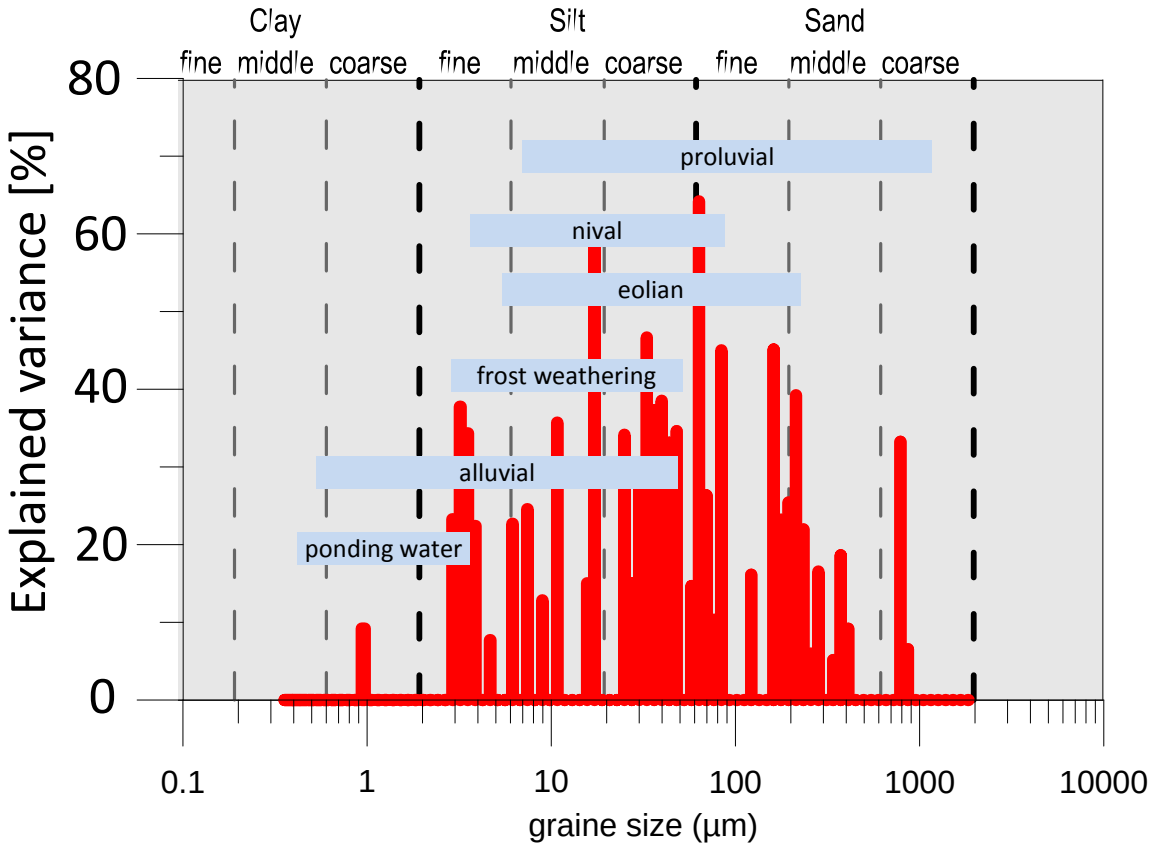




Position of the robust endmembers and its explained variances



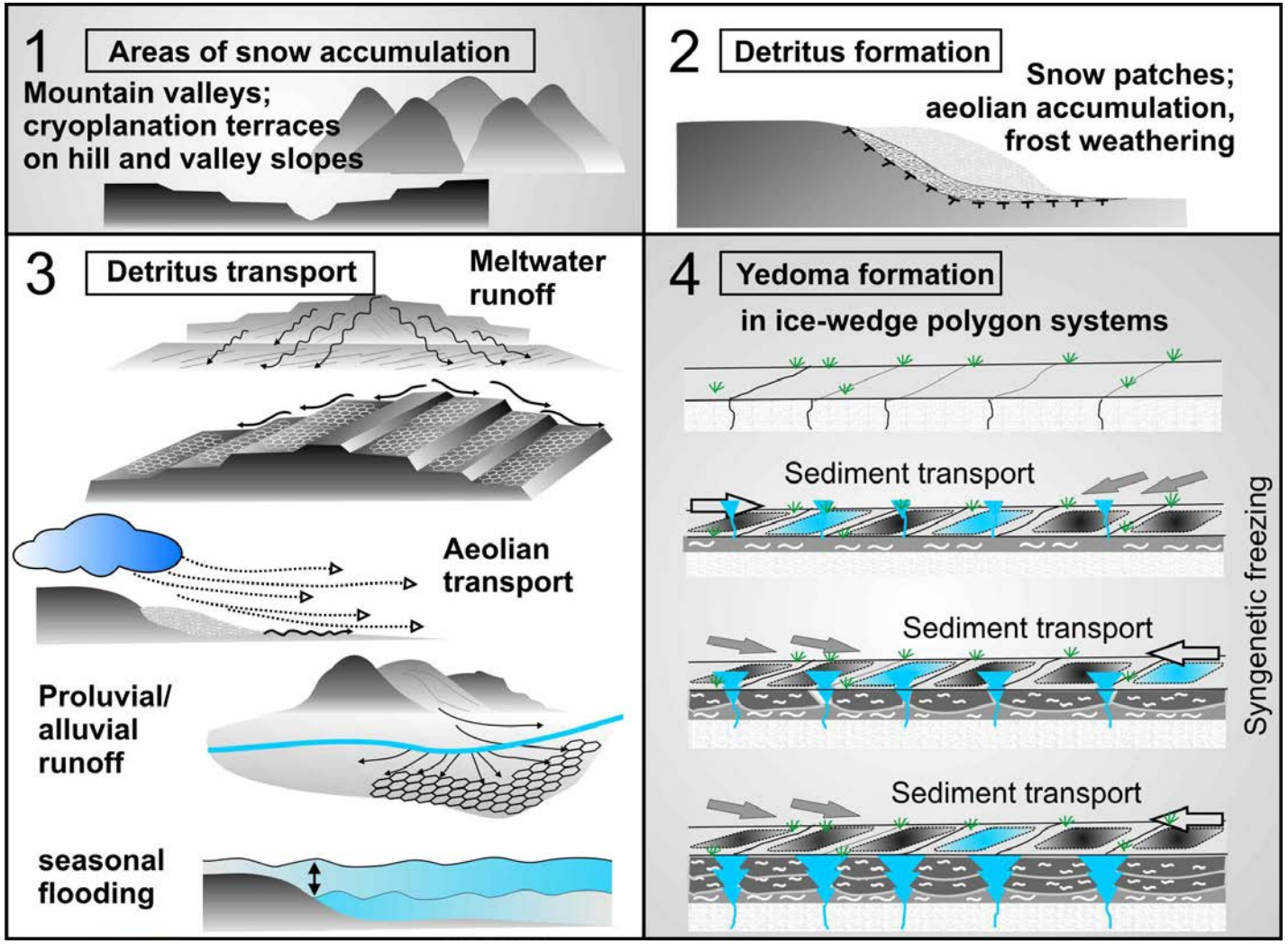
Expected processes contributing to Yedoma formation



Stacked overall explained variance of robust end-members in Yedoma deposits (n=780, 17 sites)

- **Clay:** Ponding water
- **Silt:** Eolian, alluvial (main mode at 10 µm, range 0.3-30 µm, Frost weathering: Schwamborn et al. (2012) Formation of up to 10 % of <63 µm fraction after 100-150 freeze-thaw cycles of fine-sand samples (63-125 µm)
- **Sand:** Running water (i.e. melt water runoff, braided streams), Mass movements (i.e. cryoturbation, solifluction)

The cryolithogenic concept of polygenetic Yedoma Formation



Stages of Yedoma genesis based on a cryolithogenic concept. Note: If the re-transportation of loess (also called secondary loess) is included in the loess concept, the loess and the polygenetic concepts are very similar.