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Supplement of

The influences of historic lake trophy and mixing regime changes on long-term phosphorus fraction retention in sediments of deep eutrophic lakes: a case study from Lake Burgäschi, Switzerland

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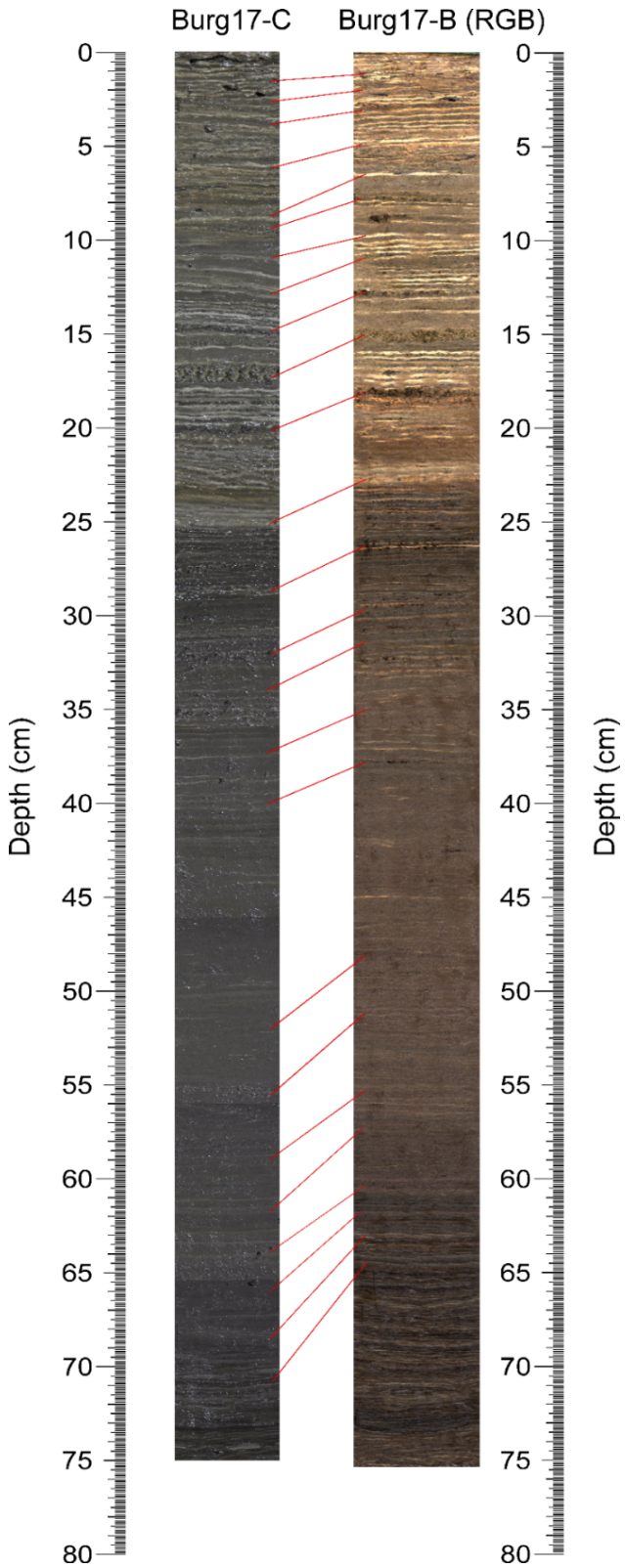

Figure S1: Core correlation between Core Burg17-C and Core Burg17-B (the dated core) sediment images. The core picture of Burg17-B is a true colour RGB (R: 640 nm, G: 545 nm, B: 460 nm) linear-stretch image. The core picture of Burg17-C was taken with a Nikon D80 digital camera.

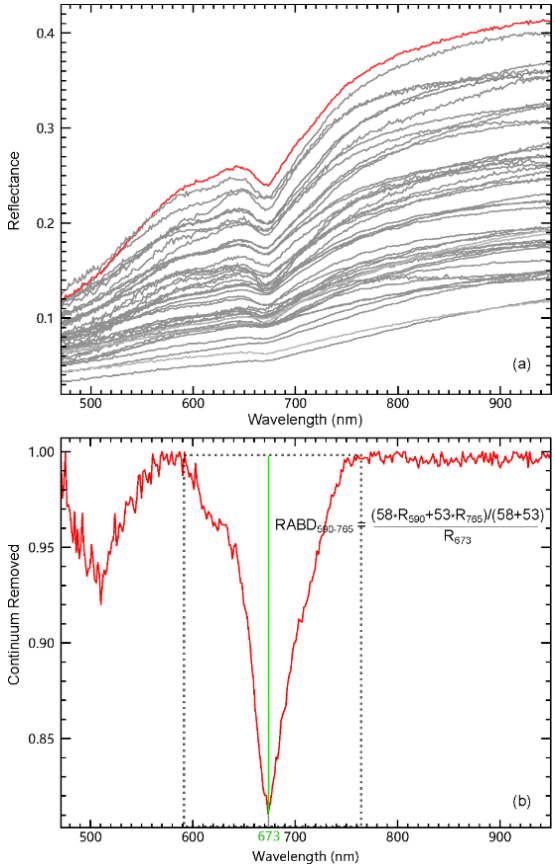

Figure S2: (a) Spectral endmembers obtained from Spectral Hourglass Wizard. The highlighted red endmember spectrum #19 is used in (b). (b) Continuum removed spectrum of endmember #19, showing the formula for $RABD_{590-765}$ calculation for a trough minimum at R_{673}.

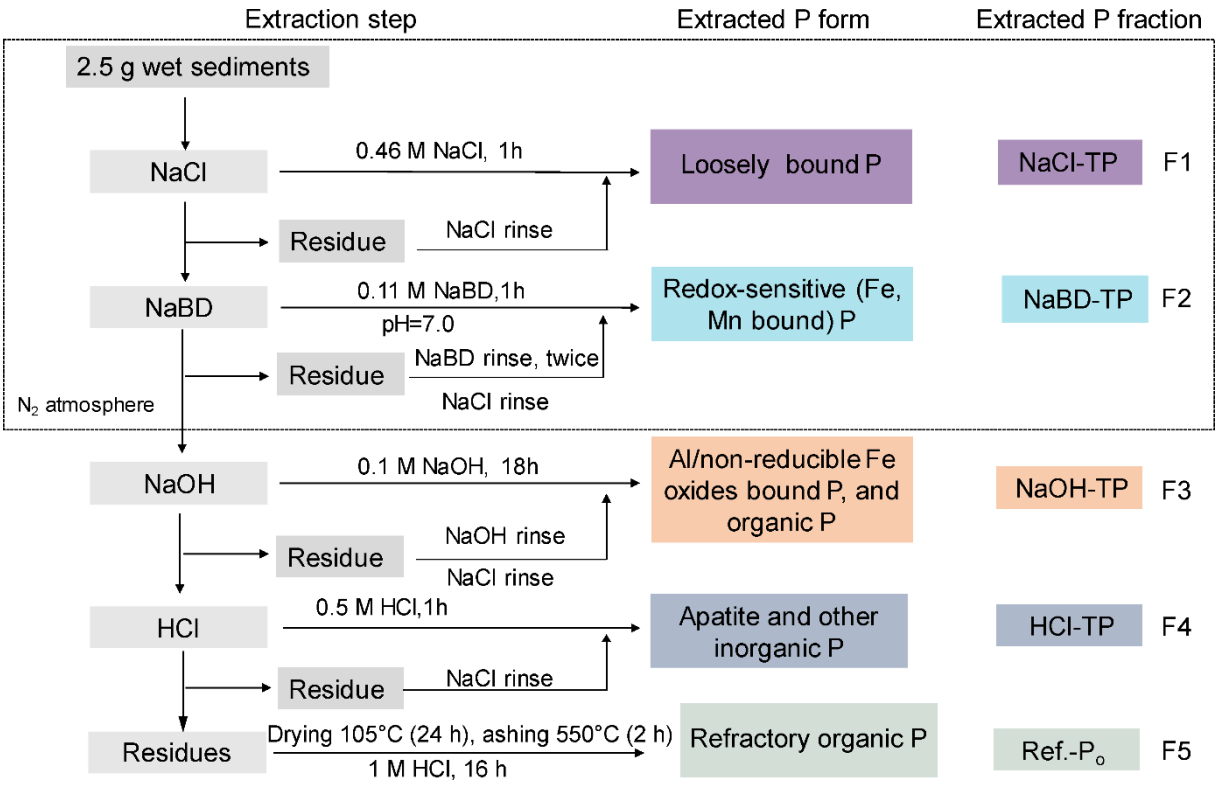

Figure S3: Five-step sequential P extraction protocol. The F1-F4 fractions follow the four-step extraction protocol in Tu et al., (2019), and F5 follows the last extraction step in Lukkari et al. (2007). Sodium dithionite ($Na_2S_2O_4$) dissolved in 0.11 M sodium bicarbonate ($NaHCO_3$) buffer (pH 7.0) henceforth is termed as NaBD.

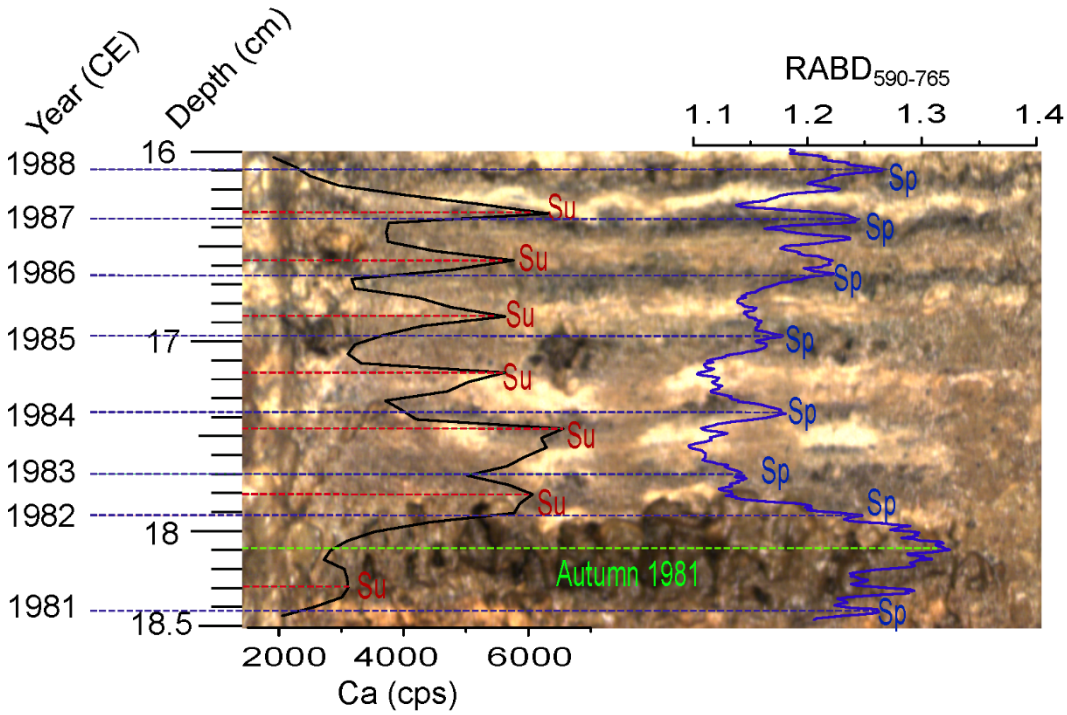

Figure S4: The laminations from depth 16 cm to 18.5 cm with a regular succession of light calcite layers (Ca-rich) and dark organic-rich ($RABD_{590-765}$ inferred green-pigments) layers indicated by different colored lines (color figure online). The background is the RGB contrast enhanced core picture (Sp: Spring; Su: Summer). The algal bloom in the autumn of 1981 year coincides with the historical record in GSA (2007).

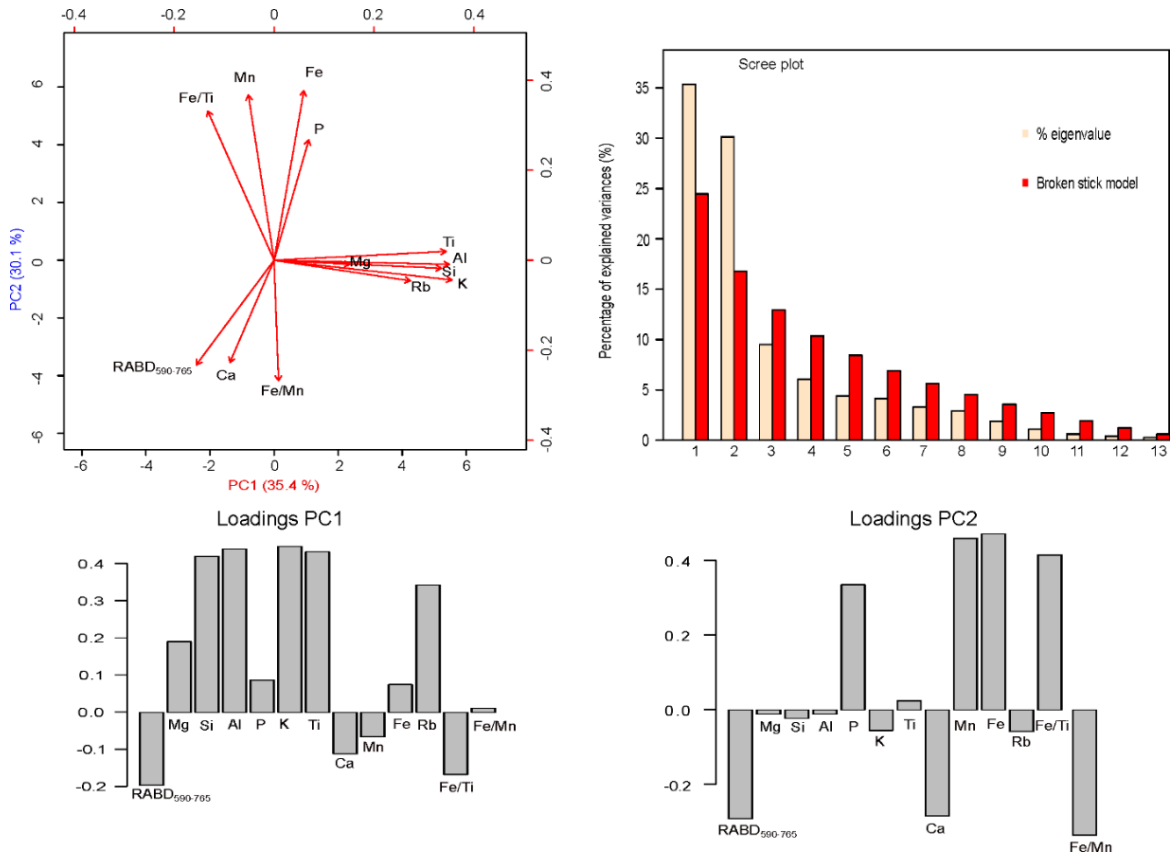

Figure S5: The biplot on standardized data of variables from Fig. 3 and S6, the screeplot and the loadings of the PCA.

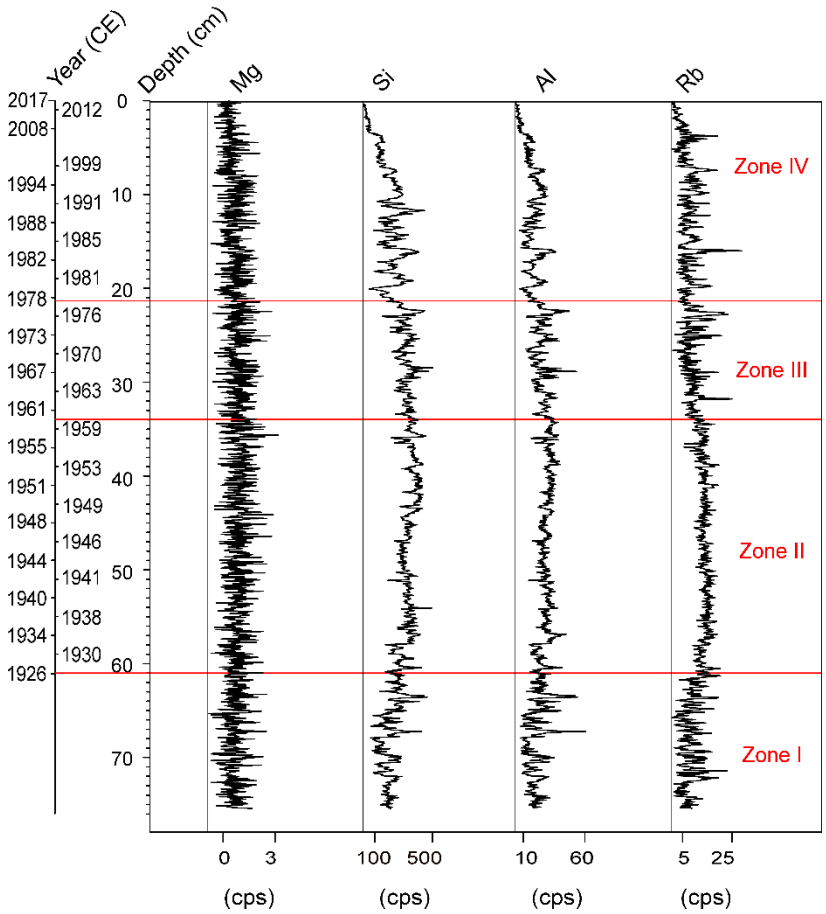

Figure S6: Stratigraphical records of several XRF-elements in sediments of Core Burg17-B. Elemental counts are represented in cps (counts per second). The red horizontal lines separate the four significant clusters retrieved by the CONISS analysis in Fig. 3.

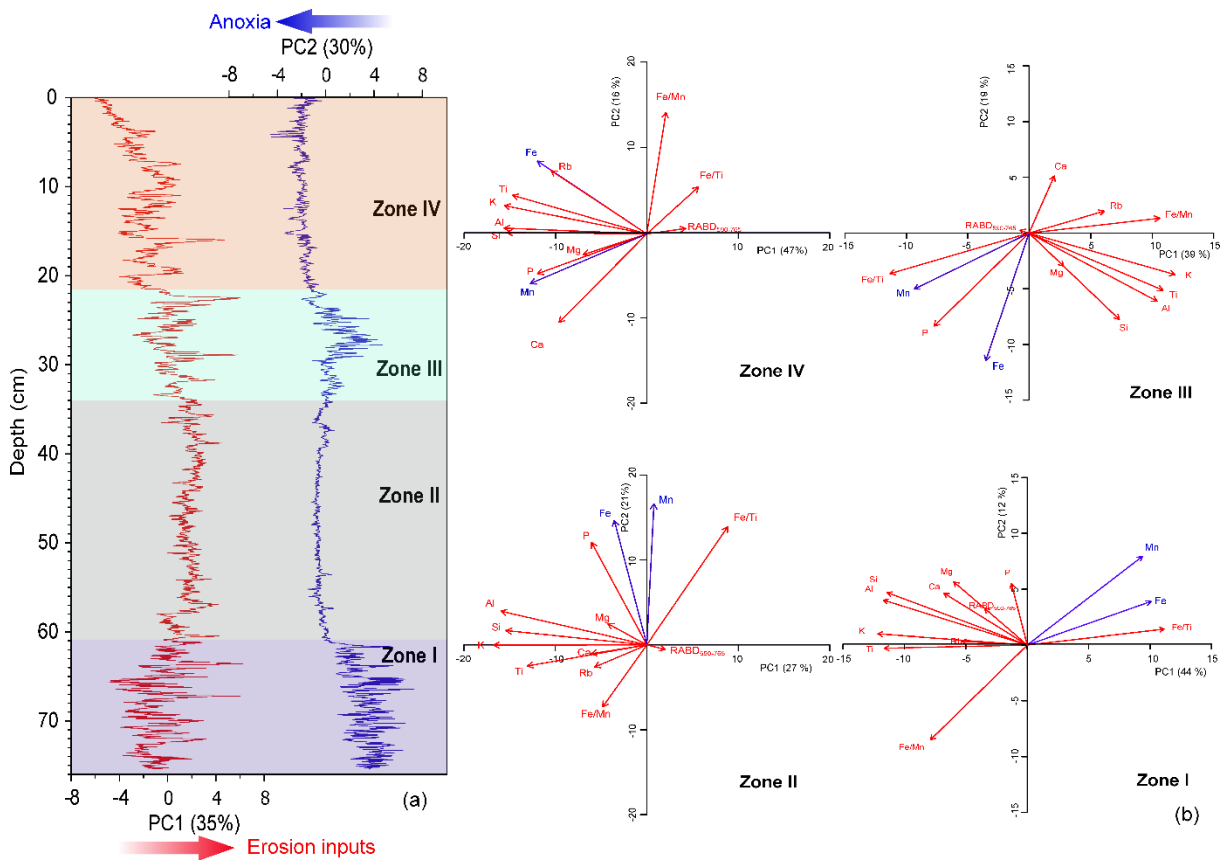

Figure S7: Multivariate analysis of green-pigments and geochemical dataset from Fig. 3 and S6. (a) Distribution of four CONISS-zones, and PC1 and PC2 scores along with the sediment Core Burg17-B. (b) Biplots of PC1 and PC2 for individual CONISS-zones in Fig. 3.

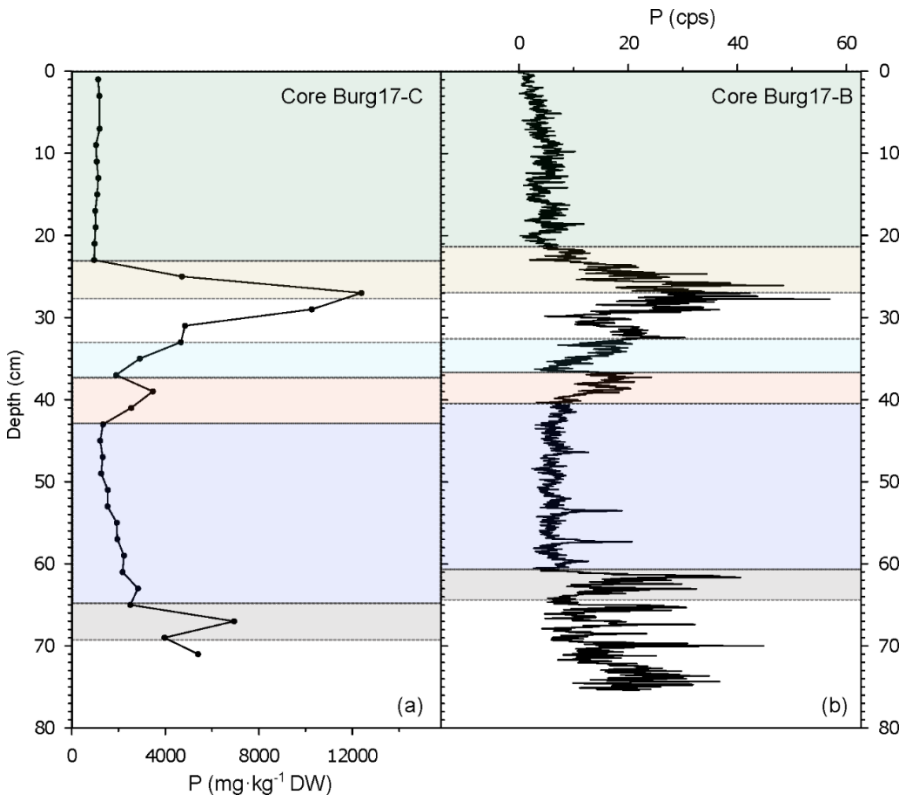

Figure S8: The profiles of (a) total P concentrations from sequential P extraction (Burg17-B) and (b) semi-quantitative XRF-P (Burg17-C). The colored sections indicate the matching between the two profiles.

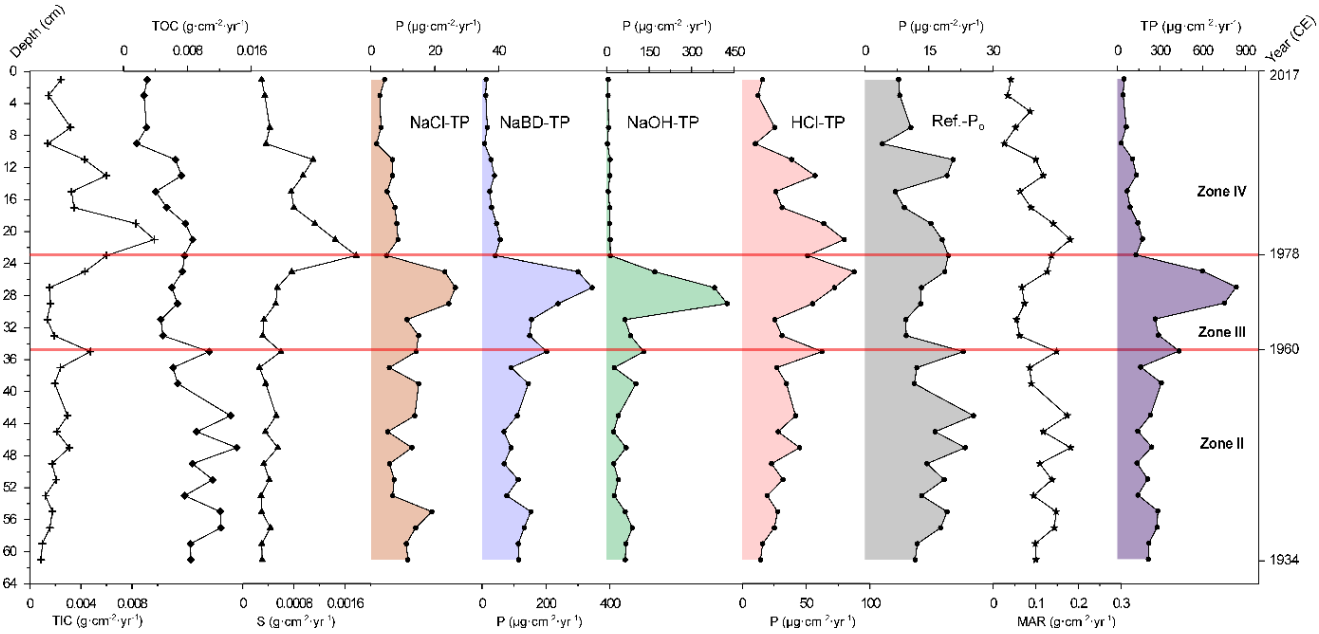

Figure S9: Net burial rates (NBR) of total inorganic carbon (TIC), total organic carbon (TOC), sulfur (S) contents, all the five P fractions, total P (TP) and the sediment mass accumulation rates (MAR) in sediments of Lake Burgäschi

between 1934 and 2017 CE. The horizontal red lines separate the significant CONISS zones as in Fig. 3 and Fig. 5. The y-axis (left) refers to the sediment depth of Core Burg17-C.

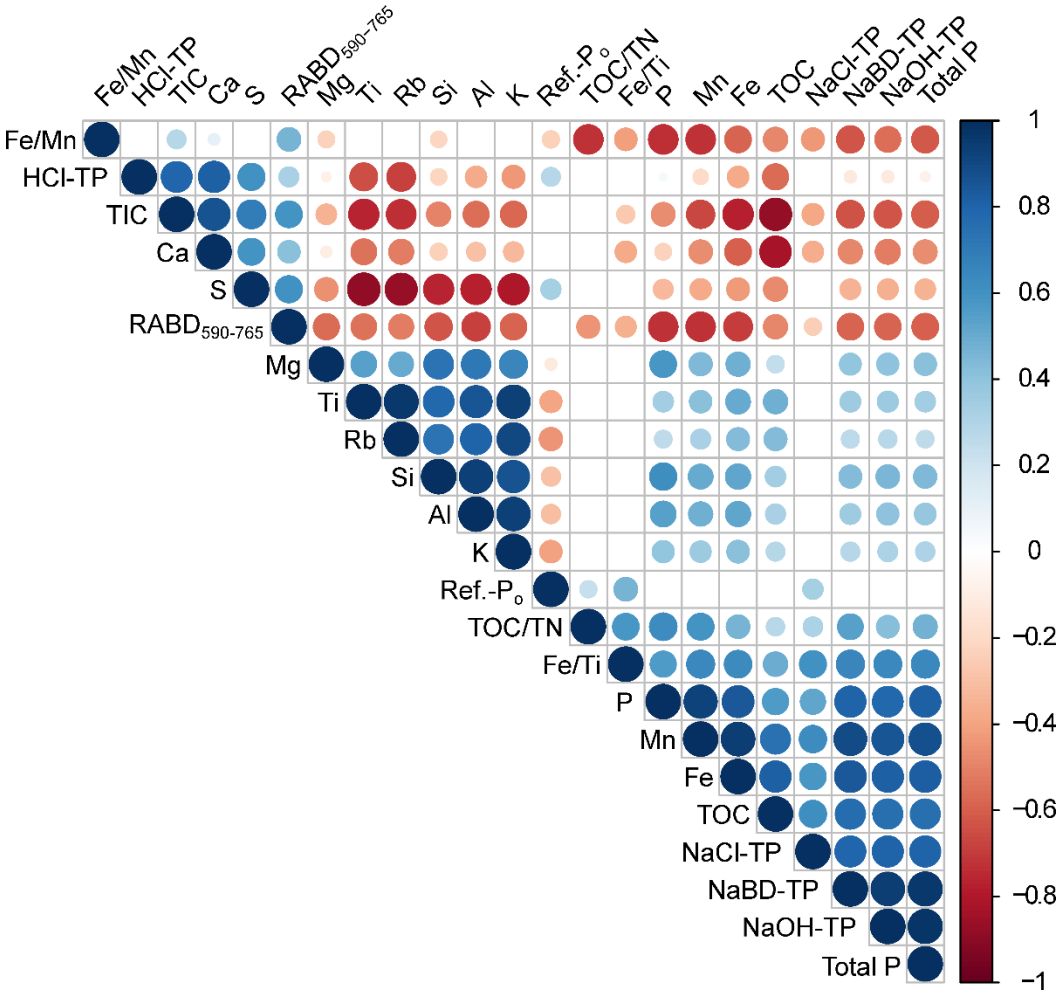

Figure S10: Spearman's rank correlation matrix of all variables (presented in Fig. 7) at the significance level of 0.05. Only the p-value of the correlation < 0.05 is shown. In total 35 samples points are included. The variable-order follows the output of hierarchical clustering.

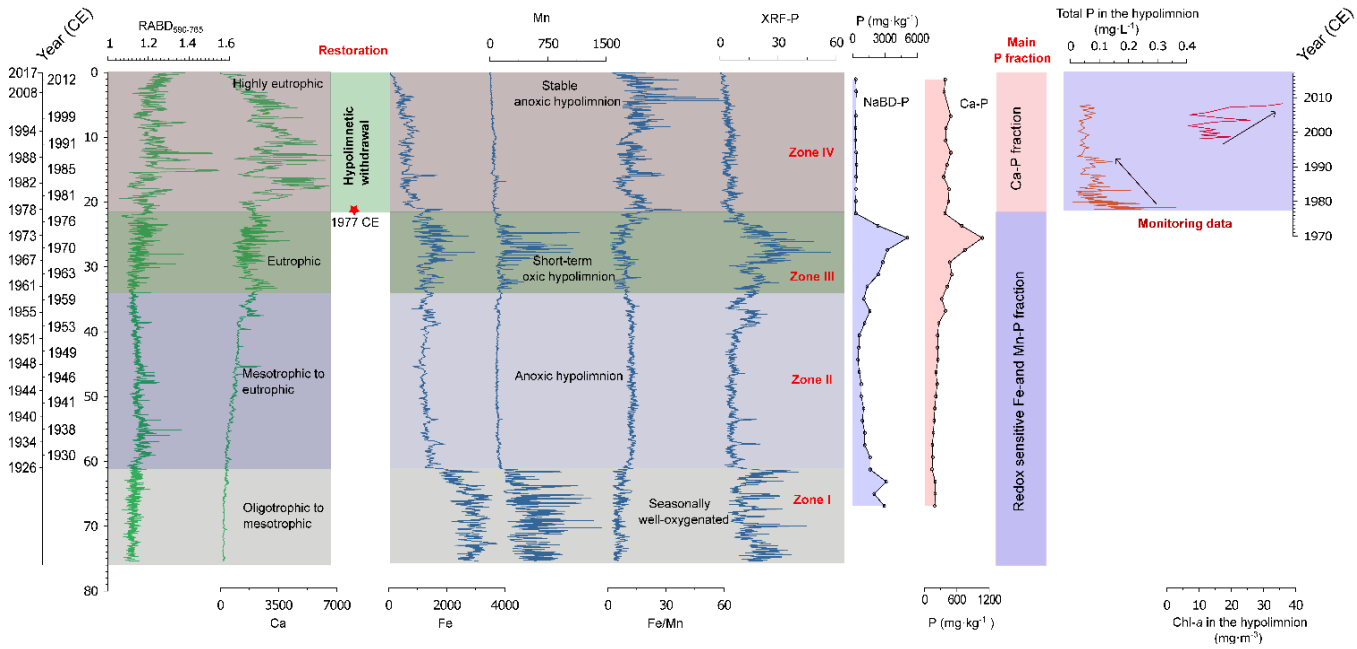

Figure S11: The synthesis of Lake Burgäschi proxy records, showing lake trophic levels, hypolimnetic withdrawal restoration, hypolimnetic redox conditions, sedimentary P fractions (e.g. NaBD-P and Ca-P) retention and lake monitoring data of hypolimnetic total P and Chl-*a* concentrations (GSA, 2007) between early 1900s and 2017.

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