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Re-interpretation of lake level changes in the Aral Sea based on diatom, mineralogical, and chemical analysis

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From 2000-2005 Philip Sapozhnikov monitored the living diatom assemblages in the Large Aral Sea which by now has reached salinities ranging between 90 to 130‰. Sapozhnikov et al. (2008) showed that diatom species are fare more tolerant to salinity then previously reported. He further noted that the bathymetric setting and the mixing state might be of more relevance then previously assumed. More specifically Sapozhnikov and co-authors observed that today A. octonarius is only thriving in at least 10 m water depth while the small benthic Nitzschia is dominant near the well-oxygenated lake shore.

Their observations motivated us to re-evaluate interpretation of diatom analysis from the core sediments. This core was retrieved from water depth of 3 m from Chernyshov Bay, a small bay at the NW end of the Large Aral Sea. The uppermost 3 m of the core cover approx. last 1.8 ky. We observed in the core repeatedly intervals with laminated sediment and high contents of biogenic material. In these intervals the taxon A. octonarius is dominant. This abundant species was replaced by the small Nitzschia sp., e.g., N. compressa, and subsequently by small Cyclotella sp. when the sediment was not laminated.

Previously periods with abundant A. octonarius were interpreted to represent lake level regression phase because it was considered as euhalobous species tolerating salinities above 30‰. Abandoning the traditional diatom salinity-based interpretation, we now propose that A. octonarius rich levels represent times when lake level was high. Such a switch in dogma is needed after Sapozhnikov et al. (2008) observed today in the hyper-saline Aral Sea several diatom species that are often reported as fresh water indicators.

Based on the new biological findings we performed additionally X-ray fluorescence (XRF) analysis in the core samples, which definitely helped to refine our previous interpretation (Bláhová et al., 2008). In our previous work we scanned with near infrared-visible (VNIR) spectroscopy method and used the data to trace gypsum and chlorophyll contents. In parallel we performed chemical analysis for determination of cation exchange capacity (CEC) and water-soluble salts. Together with diatom analysis and XRD the results, which reflect the past lake hydrology, we quantified detrital, biogenic, and chemogenic components of the sediments. The new XRF data of inorganic components from the core sediments showed some discrepancies with the VNIR results. The core levels where we previously identified gypsum based on the spectra from VNIR turned out not to be substantially enriched in Ca and S. They contain instead more Cl. Moreover the XRF data gave us a clue to interpret CEC results. The CEC curve, identical to the distribution of chemically immobile elements, clearly traces the changing amounts of salt precipitated.

Based on these new findings, we present the following lake level regression scenario for the past 1.8 ky. Lake levels were lowered between (AD) 200-500, 950-1100, 1500-1650 and 1950– recent.

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