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Productivity changes in the Arabian Sea during the past 650 years as a consequence of reduced Indus River discharge

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The northeastern Arabian Sea is of great interest since the area is sensitive to changes in the monsoonal climate with subsequent consequences for primary productivity in the ocean waters and oxygen-deficient conditions at the sea floor. The combination of high productivity in surface waters and reduced vertical water exchange promote the development of a pronounced oxygen minimum zone (OMZ) leading to accumulation of sediments rich in organic matter. A combined molecular organic and inorganic geochemical study was conducted to monitor short term variations influencing the productivity and intensity of the OMZ recorded in the sediments.

All sedimentary free lipid fractions show similar compound distributions suggesting a rather common marine source of organic matter, however, the relative amounts vary. The most abundant single components in the free lipid fractions are long-chain alkenones which are derived from haptophytes. Highly branched isoprenoids (C_{25} and C_{30}) and long-chain diols (1,14 C_{28}) which are used as diatom biomarkers are elevated in the same time interval. According to these biomarkers primary productivity has fluctuated significantly within the last 650 years. During a period equivalent to the 'Little Ice Age (LIA; prior to 1700 AD)' and during the past 70 years productivity was distinctly lower than in the period between about 1700 AD and about 1930 AD. Redox-specific biomarkers (e.g. tetrahymanol) as well as redox-sensitive trace elements (U, Cd, Mo, Sb) show synchronous enrichments in intervals of enhanced productivity proposing a strong coupling of productivity and OMZ intensity. A maximum in OMZ intensity is also indicated by high δ^{15}N values. Decreasing productivity

enhances the access of oxygen to the sediments (as indicated by the precipitation of Mn- and Fe-oxides) which amplifies the decay of organic matter. We suggest that the decrease of the surface water productivity (and weakening of OMZ conditions) is caused by reduced water discharge of the Indus thus reducing the nutrient supply to the Arabian Sea. The building of dams and irrigation facilities over the last 60 to 70 years has reduced the water and the sediment discharge drastically. During the LIA productivity was at a similar level as in recent years. During this period, which is characterized by lowered air temperatures and lowered snow lines in the Himalaya, runoff and thus Indus River discharge was reduced as part of the precipitation was retained as snow.