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Flood-related variations in provenance of fine-grained palaeochannel sediments in the Rhine river basin

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In this study, we examine flood-related variations in provenance of fine-grained palaeochannel sediments from the Bienener Altrhein (Germany), an abandoned river channel close to the apex of the Rhine river delta. Geochemical and grain size analyses were conducted on channel-fill sediments from multiple core sections, ranging from 1.15 m to 8.48 m depth, which represents pre-industrial sediment deposited from approximately 1550 AD to 1850 AD. In addition, four sediment cores of $\sim$ 1 m length were retrieved from channel-fills or overbank deposits along the Upper Rhine and the three main tributaries of the Rhine in Germany (Neckar River, Main River and Moselle River). Sediment geochemistry was analysed using an Itrax X-Ray Fluorescence (XRF) core scanner. Four elements (Ti, Co, Rb, W) were selected for further analysis based on the following *a priori* criteria: (1) The elements must be associated with minerals in the fine particle size fractions; 2) they must not be susceptible to precipitation-dissolution reactions during early diagenenis of the sediment; 3) the elements must be detected in the vast majority of the measurements; 4) the difference between the minimum and maximum number of the XRF counts for the upstream cores must be greater than 50% of the average number of counts. The XRF counts for these elements were standardised to z-scores and were subsequently corrected for the variation clay content ($<$ 2 μm) within the core and between the upstream cores by means of linear regression. The Mahalanobis distance was adopted as a measure of dissimilarity between the Bienener Altrhein sediment increments and the sediment from the upstream tributaries. The logtransformed Mahalanobis distances to the mean sediment composition of the upstream sediments were correlated to the medium to coarse sand particle size fraction ($>$ 150 μm), which was primarily deposited during historical flood events. The results show the Mahalanobis distances are larger than 1 for most increments, which indicates that the four sampled upstream sites do not entirely cover all sources of sediment deposited in the Bienener Altrein channel. The logtransformed Mahalonibis distance correlates significantly (α = 0.05) with the $>$150 μm particle size fraction for the Upper Rhine River (negative) and the Moselle River (positive). This implies that the proportion of fine sediment that originates from the upper parts of the river basin and, hence, the sediment transport distance increases with flood magnitude. These results provide an excellent starting point to reconstruct the origin of historic flood events as documented in the sedimentary records of channel fills and dike breach ponds.