**Supplementary Figure captions**

**Supplementary Figure 1.** Reference versus predicted element concentrations for ODP967, based on conventional and scanning XRF, and application of a multivariate log-ratio calibration model (Weltje et al., 2015).

**Supplementary Figure 2.** Detecting outliers in the calibrated scanning XRF data. Cut-off thresholds (dashed lines) based on the Mahalanobis distance *d* (red) are shown for ‘extreme’ outliers (3rd quartile + 3\*IQR; green), ‘mild’ outliers (3rd quartile + 1.5\*IQR; blue), and an empirically derived cut-off (*d* >18; black). Records of Ba, the theoretical ‘everything else’ variable, and Ca are shown for all data (red) and after outlier removal based on the above thresholds. Sapropel intervals are characterised by reduced colour reflectance (L\*) in ODP967 (Emeis et al., 199; rescaled to our composite depth scale).

**Supplementary Figure 3.** Regression analyses of ODP967 scanning XRF counts and their calibrated concentrations before (a) and after (b) removal of outliers.

**Supplementary Figure 4.** ODP967 element/Ti ratios based on fully-calibrated scanning XRF concentrations (blue) and WD-XRF (orange; TK2014, rescaled to our composite depth scale).

**Supplementary Figure 5.** Construction of ODP967 age model. a) Power spectrum for ‘PC2’, with 9-point running average in black. 90% (green) and 95% (red) confidence intervals were estimated based on a Monte Carlo simulation involving generation of 1000 surrogate time series with the same first-order autoregressive characteristics as the original time series”. b) The PC2 record (blue) and after applying a 1.75±0.25 band-pass filter (orange) on composite depths, and the tuning target (precession; green) on age. Ties based on tuning (black crosses) and radiometrically constrained ages (red crosses) are indicated. Dotted lines are shown for selected ties only, for visual clarity. c) Filtered PC2 record (orange) after tuning, superimposed on the target precession curve (green), and sedimentation rates (SR) based on linear interpolation through ties (black). The depth and inferred age of a sediment slump in ODP967 is indicated (grey shading).

**Supplementary Figure 6.** Comparison of ODP967 chronologies. a) ODP967 dust record (Larrasoaña et al., 2003) on its original chronology (blue; from Sakamoto et al., 1998) and rescaled to the new chronology (this study; orange). b) ODP967 Ti/Al records (Lourens et al., 2001; Konijnendijk et al., 2014) on their original chronology (blue) and rescaled to the new chronology (this study; orange).

**Supplementary Figure 7.** Bi-plot representation of ODP967 XRF reference and calibrated samples based on a principal component analysis. Scores of the reference samples (green) and calibrated scanning-XRF data (red), and coefficients of the 12 elements (blue vectors), are plotted on the first two principal components.