Chapter 4

PARTICLE SIZE CONTROLS SEDIMENTARY CHEMICAL DISTRIBUTION IN A LARGE RESERVOIR, LAKE POWELL, USA

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Abstract

Trace elements are known to associate with small particles in the solid phase. In reservoirs, physical processes can separate sediment into geographical regions of varying particle size. We collected sediment cores from the lakebed and shoreline of Lake Powell, a large reservoir on the Colorado River, southwestern USA, and measured particle size, elemental abundance, total and organic carbon, and mineral composition in sediment samples. We observe a spatial trend in particle size in the delta sediment of Lake Powell, but no statistically significant trends along the shoreline. Organic carbon and most major and trace elements anticorrelate highly significantly with particle size. Thus, geographical location within the Lake Powell deltas predicts solid-phase chemical concentrations. This finding may have implications for water quality during reservoir drawdown, a process that leads to resuspension of delta sediment by the inflowing rivers.

Introduction

Sedimentation occurs in reservoirs as a consequence of damming. Physical studies of sedimentation have focused on the rate, texture, and spatial distribution with applications to watershed erosion (Bennett et al. 2005) and river restoration (Cheng and Granata 2007; Snyder et al. 2004). This process also has chemical implications because reservoirs can be long-term sinks for sediment enriched in inorganic contaminants (Kneebone et al. 2002; Castelle et al. 2007; Lee et al. 2008) or nutrients (Orr et al. 2006; Riggsbee et al. 2007; Downing et al. 2008). Furthermore, chemical analyses of reservoir sediment can answer questions about long-term contaminant transport in watersheds (Bennett and Rhoton 2007) and influent stream quality of urban reservoirs (Van Metre and Mahler 2004).

Solid-phase trace element concentrations increase with decreasing particle size in reservoirs (Bennett and Rhoton 2007) and river suspended sediment (e.g., Horowitz and Elrick 1987). Mechanistic determinations of this phenomenon are problematic; particle size (and, by extension, surface area) and geochemical phase (i.e., organic carbon (org-C) content) are so interrelated that it is unclear which dominates metal transport (Horowitz and Elrick 1987). In separate, controlled experiments, vermiculite, a clay mineral, and lignite, a C-rich solid, have shown similarly high sorption of metals (Maladrino et al. 2006, Mohan and Chandler 2006).

If particle size predicts trace elements concentrations, then sedimentation patterns should influence the geographic distribution of trace elements in a reservoir. Previous studies of chemicals in reservoir sediment have generally occurred in reservoirs where trends in physical sorting of sediment and spatial distribution of chemicals seem unimportant. However, in a large reservoir, the sediment delta can extend over tens of km and physical sorting may lead to physically and chemically distinct regions of sedimentation. Furthermore, different tributaries may contribute distinct sediment loads, possibly leading to further heterogeneity.

This chapter examines sediment particle size and deposition as two factors that control of the fate of elements in Lake Powell, a large reservoir on the mainstem of the Colorado River in southeastern Utah and northern Arizona. This reservoir traps >99% of its sediment load (Topping et al. 2000), far more than similar reservoirs (Syvitski et al. 2005). Furthermore, its sediment may have a higher chemical load than other reservoirs, due to a history of mining in the Upper Colorado River Basin (Farmer 1999; Spahr et al. 2000). We hypothesize that 1) particle size, org-C, and chemical content of sediment will correlate here, 2) particle size is controlled by location within the Colorado River delta of Lake Powell, with downstream samples containing more fine particles and org-C, and 3) shoreline particle size is influenced by local geology.

Sampling and Analytical Methods

Sediment in Lake Powell. The closure of Glen Canyon Dam (GCD) in 1963 impounded the turbid Colorado River and created Lake Powell, which is 299 km long when full. It stores >30 km^3 of water for 25 million people and >6000 km^2 of farmland. Its sedimentation rate has been estimated at 21-52 Mt yr^{-1} (Ferrari 1988, Horowitz et al. 2001), implying a lifetime of 601-1488 years. Most sediment reaches Lake Powell via the Colorado and San Juan Rivers, which drain the southern Rocky Mountains, contribute 80% and 15% of the water to the lake, respectively, and build large deltas into the two upper arms of the reservoir (Figure 1; Potter and Drake 1989). Additionally, 95 tributaries, each with its own "side canyon", flow into Lake Powell intermittently and deposit ~10% of the Lake Powell sediment load away from the thalweg and main deltas of the reservoir (Potter and Drake 1989). Many side canyons are <20 km long and are surrounded by only one type of rock formation (Anderson et al. 2003). Supporting information section S1 provides additional detail on sedimentation in Lake Powell. This study focuses on the Colorado River delta, which is assumed to be generally representative of processes in the San Juan River delta, and side canyon sediment.

Sediment collection. "Lakebed" sediment cores were collected from the thalweg of Lake Powell on 21-23 March 2006. Gravity cores were collected in plastic, 5 cm × 1 m core liners, at locations, identified by their distance in river km upstream from GCD (all rounded to the nearest 0.5 km), in a longitudinal transect through the upper region of Lake Powell. Samples were collected in (245.0, 241.2, 238.7, and 235.4 km) and below (168.0 km) the Colorado River sediment delta (Figure 1, see Table S1 for exact locations). Samples were kept cool after sampling, transported on ice to the laboratory, and frozen within 3 days of collection.

Sampling followed a 6-month period during which lake levels were steady for 3 months and slowly fell for the 3 months immediately before sampling (Figure S1). This should have minimized complications from changing lake levels, which influence the location of sediment deposition. To check this assumption, 4 cores (at 241.2 km, 238.7 km, and replicates at 178.0 km; Figure 1, Table S1) were collected on 16-18 May 2006, when the lake level had risen 2.6 m from the level of the March sampling. Colorado

River flow, taken as the sum of flow past United States Geological Survey (USGS) gages on the Green River at Green River, Utah and the Colorado River near Cisco, Utah, was ~192 $m^3 s^{-1}$ in March and ~668 $m^3 s^{-1}$ in May (USGS 2008).

Since the Colorado River delta aggrades ≤2-3 m yr^{-1} (Ferrari 1988), we assume that the top 20 cm of a delta sample represents accumulation from only the previous months. Our analyses focus on these "surface" (0-20 cm depth) samples, but they are presented along with some "deep" (25-80 cm depth) samples for comparison. Sediment accumulation rates in the middle of the lake are much less than in the delta. Cores collected at 168.0 km and 178.0 km were sampled as close to their surfaces as possible and these may contain sediment deposited over a longer period of time. No effort was made to date sediment.

We also collected "delta shoreline" samples from shore locations 247.5 and 249.5 river km above the dam, respectively, that were above the water line (Figure 1, Table S1). For these samples and those in side canyons (described below), repeat sampling or different sites at the same general location are denoted by a letter following the distance from GCD or side canyon abbreviation. Samples were collected 12 April 2005 (sample 247.5 A), 18 June 2005 (247.5 B), 5 December 2005 (247.5 C). At the 249.5 km location, 1.5 vertical m of sediment were collected in a set of stacked cores on 21 March 2006.

Fourteen sites were sampled in 7 side canyons: Navajo Canyon (NC), Moqui Canyon (MC), Trachyte Canyon (TC), White Canyon (WC), Farley Canyon (FC), the Dirty Devil River (DD). Also, a sample collected from a bank of the San Juan River (SJ) is included in this set (Figure 1, Table S1). Sampling occurred on 7 February 2005 (WC A), 12-13 April 2005 (WC B), 19-23 June 2005 (NC A, NC B, SJ, MC, and WC C), 4-5

December 2005 (WC D), 22 March 2006 (TC A), 17-19 May 2006 (TC B, FC B, and DD), and 27-28 March 2007 (WC E and FC B). All samples were collected <2 m from the edge of the lake except for NC B. This sample came from sediment submerged in a pool of water beneath a small waterfall ~100 m from the lakeshore. Cores were kept cool during transport to the laboratory and frozen <6 (usually <3) days later. All shoreline cores were collected in butyrate core liners (diameter = 2.5 or 5 cm) pushed into the sediment by hand.

Laboratory Processing and Analyses. Lakebed sediment cores were inspected visually and sampled anoxically based on distinct differences in color and particle size between sedimentary layers. Where no visual changes with depth were observed in delta shoreline or lakebed cores for >20 cm, two samples were often selected for analyses; otherwise, one sample represents a single section. No obvious layers existed in side canyon samples, so cores collected in 2005 were sectioned at 2 cm intervals under a low-oxygen atmosphere and later combined to provide sufficient mass for analyses. Cores collected in 2007 were sectioned anoxically at 4- or 8-cm intervals.

Each sample was thawed, homogenized, and freeze-dried. Most samples from lakebed and delta shoreline cores were analyzed for most parameters. Usually, only the top 10 cm of side canyon cores were analyzed, but additional depths of some cores were measured for some parameters. In total, 113 samples were analyzed for at least one parameter. Overlapping depth ranges from the same location originate from replicate cores.

Particle size was measured with a Mastersizer 2000 laser diffractometer (Malvern Instruments Ltd., Worcestershire, UK) following Sperazza et al. (2004). Elemental abundance of most elements from Na to U was measured with a XEPOS energy dispersive X-ray fluorescence (XRF) spectrometer (Spectro Analytical Instruments, Inc., Mahwah, NJ). Carbonate minerals were extracted from sediment samples with hydrochloric acid. These and untreated sediment samples were analyzed on a 2010 Elemental Combustion System (Costech Analytical Instruments, Valencia, CA). Mineralogical composition was measured on a D500 X-ray diffractometer (Siemens AG, Berlin), and the X-ray intensities were analyzed using RockJock software following Eberl (2003). Supporting Information sections S2, S3, S4, and S5 contain details of particle size, elemental abundance, carbon, and mineralogical measurements, respectively.

Data Analyses. Data sets in this study were collected as mass percentages and subsequently expressed as molar ratios with elements and minerals normalized to silicon and silica, respectively. Molar ratios of minerals were calculated using molar masses presented by Klein and Hurlbut (1999). Data were compared by creating a matrix of correlation estimates (“correlations”) using the software packages R 2.1.1 and R 2.8.0 (R Development Core Team 2005, 2008). Two separate arithmetic tests for the influence of particle size were carried out in which data for 17 samples that included all parameters were either divided or multiplied (one operation in each test) by the mean particle size of each sample. Relative standard deviations were computed for this data set. A linear regression model was created using mean particle size as the predictor variable and all elemental and mineralogical molar ratios as response variables. The residuals from this model were then correlated with all other parameters as another test of the influence of particle size. Errors of correlations are assumed to have a normal distribution, which implies that the standard deviation (σ) of these errors is $1/\sqrt{n}$, where n is the number of samples. Correlations 2σ and 4σ from zero are considered significant and highly significant, respectively. Where carbon concentrations or elemental abundances were below detection limits (BDL), values of 0.01% or 0.00005% were used.

Results

Thirteen sediment cores collected from 5 lakebed locations varied in length from <30 cm to >60 cm. No significant variability was observed during visual inspection of these cores, so the top and bottom of each core were usually sampled. Visual differences were obvious in delta shoreline samples, especially in the cores collected 249.5 km from GCD. A total of 8 samples were collected from clayey layers at depth ranges -132 to -109 cm (negative values indicate depths above the sediment-water interface), -47 to 14 cm and 14 to 20 cm and sandy layers at -109 to -77 cm and -77 to -47 cm (see Figure S2 for photographs). Additionally, a sandy layer that was not sampled overlaid the top clayey layer. These sediment layers almost certainly represent sediment deposited during very different lake levels at this location, in contrast to the lakebed samples, which were collected at different locations and two very similar lake levels. Side canyon cores showed no visible variation with depth and were sandy, brown, and odorless except for NC B, which was black and smelled of hydrogen sulfide, and TC A and TC B, which contained visible layers of small plant debris. Core 247.5 C also contained plant debris.

Particle Size. Sediment in Lake Powell is a mixture of silt (mean <2 μm), clay (2-63 μm), and sand (>63 μm) with sample means ranging from 5-445 μm, an overall mean of 86 μm, and an overall standard deviation (σ) of 93 μm (Table S2). The lakebed samples (mean = 10.4 μm, σ = 6 μm) were significantly finer (t-test, $p < 0.01$) than both the shoreline delta samples (mean = 135 μm, σ = 127 μm) and the side canyon samples (mean = 112 μm, σ = 77 μm), which were not significantly differently from each other.

The mean particle size of lakebed surface samples collected in March 2006 correlates with distance from Glen Canyon Dam (Figures 2, S3). This trend also occurs in the two samples collected in May 2006, which are notably coarser than the corresponding locations in March (Figures 2, S4). Deep samples are coarser than surface samples at all locations analyzed (Figure 2, Table S2).

The apparent similarity of the delta shoreline and side canyon samples is somewhat misleading. Whereas the set of all side canyon samples has an apparently random distribution, the delta samples have a trimodal distribution, with 3 samples near 130 μm, 6 samples <45 μm, and 4 samples near 300 μm (Table S2). This reflects the distinct sediment layers, one of which is much coarser than most side canyon samples (and all lakebed samples) and one of which is much finer than the side canyon samples.

Mean particle sizes of samples from side canyons surrounded by sandstone rock formations, NC, WC, and MC, are 168, 147, and 120 μm, respectively. Canyons surrounded by shale formation, TC and FC, have mean particle sizes of 104 μm and 80 μm. Thus, the type of rock surrounding a side canyon may predict the particle size of the sediment therein. However, these differences are not statistically significant (t-test, $p < 0.05$) and greater numbers of samples would be required to validate this trend.

Elemental Abundance. Inorganic elements were measured in 71 lakebed, delta, and side canyon samples (Tables S3A, S3B). Lake Powell sediment is mostly composed of Na, Mg, Al, Si, K, Ca, and Fe (concentrations generally >0.5%) with minor amounts of P, S, Ti, and Mn (concentrations >0.01%). At trace levels (<0.01%), Rb, Sr, Ba, Ce, Cl, and Zn were usually present and V, Cr, Ni, Cu, Ga, As, Br, Y, La, Pb, Th, and U were occasionally found. When Zr was measured, it was >0.01%, but, in many samples were BDL. The many samples BDL imply that, if contamination by the ZrO milling balls occurred, it is less than the XRF detection limit. Thus, Zr will be included in this analysis. Concentrations of Se were usually BDL.

Results are not consistent across the three groups of samples. A majority of elements (Mg, Al, P, K, Ca, Ti, Mn, Fe, Ni, Zn, Ga, As, Br, Rb, Sr, Y, Pb, Th, U) are significantly higher (t-test, $p < 0.05$) in lakebed samples than in side canyon samples; the opposite is true for Si and Zr. In all samples, Cl, S, and K are approximately near median crustal abundance (MCA) values, and Ba exceeds this value (Lide 2007). In the lakebed samples, Ca, Zn, Br, Rb, Pb, Th, and U exceed MCA values, and Si and Zr exceed them in most side canyon samples. Comparison of delta shoreline samples to lakebed and side canyon samples was not considered useful because, as with the particle size results, specific depths sampled at the delta shoreline resembled either the lakebed or side canyon sample sets.

Org-C was analyzed in 15 lakebed, 11 delta shoreline, and 58 side canyon samples; total C was analyzed in 13 lakebed, 13 delta shoreline, and 67 side canyon samples (Tables S3A, S3B). Generally, org-C is very low, except in the three cores that contained plant debris (249.5 C, TC A, TC B). When these samples are removed from the analysis, lakebed samples contain significantly more (t-test, $p < 0.01$) organic (mean = 1.00%, σ = 0.28%) and total (mean = 3.15%, σ = 1.52%) C than side canyon samples, which average 0.15% (σ = 0.19%) organic and 1.61% (σ = 0.71%) total C. Notably, one total C value (8.55%) from the 178 km lakebed location is a high outlier, perhaps due to high precipitation of calcite, which is unlikely, but possible, in this region of Lake Powell (Reynolds 1978). However, a duplicate core collected at this location contained only 3.50% total C.

Mineralogy. Mineral composition was measured in 8 lakebed samples, 8 shoreline delta samples, and 6 side canyon samples collected from Lake Powell. Lakebed samples contain slightly more clay minerals (mean = 51.7%, σ = 6.3%) than non-clay minerals (mean = 45.5%, σ = 7.6%; Tables S4A, S4B). This is significantly different (t-test, $p < 0.01$) than side canyon samples, which average 94.5% non-clay minerals (σ = 1.5%) and 10.7% clay minerals (σ = 1.6%). Of the non-clay minerals, quartz dominates, followed by calcite, dolomite, multiple feldspars, iron-oxide minerals, and apatite. Calcite, dolomite, apatite, and maghemite are higher in the lakebed than in the side canyons, whereas the opposite is true for quartz. Of the clay minerals in the lakebed samples, illites dominate, followed by muscovite, smectites, and kaolinite.

Correlation between particle size, elements, and minerals. Due to varying numbers of samples in each analysis, separate significance thresholds were created for each pairing of data sets (Table S5A). Correlation analysis was completed after samples with visible plant debris (247.5 C, TC A, and TC B) were removed from the data set.

All particle size parameters analyzed (mean, median, mode, and the logarithms of these) correlate positively and highly significantly with each other. Henceforth, only the mean particle size (MEAN) and the logarithm of the mean particle size (log(MEAN)) will be discussed, but all correlations are presented in Tables S5B and S5C, which correspond to the mass percent and molar ratio data, respectively. Trends between correlations based on mass percentage and molar ratios are similar; only the latter will be explicitly reported and discussed for all elements and minerals here except silicon and silica. Both MEAN and log(MEAN) anticorrelate highly significantly (-0.672 and -0.887) with org-C. Anticorrelations of total C with MEAN and log(MEAN) are significant (-0.537) and highly significant (0.732), respectively (Table S5C, Figure S5). These observations are consistent with published results (e.g., Horowitz and Elrick 1987), and the stronger correlation between carbon and the logarithm of particle size parameters suggests a nonlinear dependence of C concentration on particle size that has not been previously described.

Both log(MEAN) and org-C anticorrelate and correlate highly significantly (i.e., $r < -0.556$ for particle size and >0.539 for org-C), respectively, with most metals analyzed, i.e., Mg, Al, P, K, Ca, Ti, V, Mn, Fe, Ni, Zn, Ga, As, Br, Rb, Sr, Y, Pb, Th, and U. This trend is reversed for Si and Zr. Thus, the influence of particle size and organic carbon on metal concentrations in sediment is closely linked: with the exception of Si and Zr, major and trace elements associate with small particles that are high in org-C.

Molar ratios of non-clay minerals correlate highly significantly (i.e., $r > 0.853$) with log(MEAN) and anticorrelate significantly with org-C (i.e., $r < -0.459$), whereas the opposite is true for total clay minerals (Table S5C, Figure S6). Within these categories, most individual clay minerals anticorrelate significantly with log(MEAN), yet the same is not true for non-clays. Some feldspars, Goethite, and quartz correlate significantly with log(MEAN), whereas calcite, dolomite, and maghemite anticorrelate significantly with this parameter. Furthermore, elements that associate with smaller particles generally correlate and anticorrelate with clay minerals and non-clay minerals, respectively. This both agrees with previous work showing that clay minerals are known to sorb metals very effectively (Malandrino et al. 2006) and suggests that trace elements may be scavenged during precipitation of carbonate minerals (i.e., calcite and dolomite) or, in the case of certain metals (e.g., manganese and iron) incorporated into the mineral structure (Friedl et al. 1997; Prothero and Schwab 2004).

Effects of Particle Size. The two separate arithmetic tests in which the values of elemental or mineralogical molar ratios of 17 samples were either divided or multiplied by MEAN led to relative standard deviations that were always larger than 50% and often larger than 100% (analysis not shown). The residuals of a linear regression model using MEAN as a predictor variable and all other parameters as response variables correlated positively and significantly (i.e., $r > 0.485$) with total C, Al, P, S, Ca, V, Cr, Mn, Fe, Cu, Zn, Ga, As, Br, Rb, Sr, Ba, Pb, Th, U, orthoclase feldspar, albite feldspar, oligoclase feldspar, calcite, maghemite, apatite, disordered kaolinite, ferruginous smectite, 1Md illite, 1M illite, Fe-chlorite, muscovite, total non-clays, and total clays.

Discussion

Particle size and location in the Colorado River delta. Particle size trends created by the deposition of the Colorado River delta exist over several kilometers and can be observed in surface sediment during periods of relatively steady lake level (Figure 2). This agrees with other studies in which reservoir sediment deltas do not reach dams (e.g., Snyder et al. 2006, Riggsbee et al. 2007). Although particle size may influence spatial distribution of elements and minerals in this system, the large variations in data normalized to particle size and the significant correlations of some elements and minerals with the residuals of a linear model based on particle size imply that it is not the exclusive driver of elemental and mineralogical abundance in Lake Powell sediment. When the influence of particle size is removed, other factors like the abundance of clay and non-clay minerals or the concentration of organic carbon may play an important role.

The coarser mean particle sizes of deeper samples probably result from movement of the depositional region due to changes in lake level. Before the steady lake levels of late 2005 and early 2006, the surface elevation of Lake Powell had risen ~17 meters in spring/summer of 2005 after >1 year below the elevation of March 2006, when sampling occurred (Figure S1). At a lower lake level, the region of sediment deposition would have been closer to GCD, leading to coarser particles underlying finer particles at our sampling locations. Variations in reservoir level exert a complicated influence on particle size (Snyder et al. 2006). While the details of this relationship are beyond the scope of this study, broad differences observed between our samples are consistent with the recent surface elevation changes in Lake Powell.

The distinct sediment layers sampled at the delta shoreline locations provide further indication that different lake levels lead to deposition of different particle sizes in a given location. The alternating coarse and fine layers from the 249.5 km location indicate that the Colorado River deposits sediment that ranges from <10 to >300 μm, a much wider range of particle size than we observed in our lakebed samples. Since particle size decreases away from the river inflow in a long, narrow delta, this implies that our lakebed locations sampled only the downstream end of the sediment delta and that the upstream portion of the delta is probably composed of sand. This fraction may be very large; we recently observed sediment banks >10 m high 271.5 km from GCD. Thus, our data imply that small trends in particle size (i.e., a change in mean of a few μm over <10 km) can be observed after months of steady sedimentation and major trends may be robust over tens of km.

Sedimentation in Lake Powell is an active process, and several physical processes can complicate the trend of particle size increasing with distance from the dam. Our samples collected in May 2006 are notably coarser than those collected in the same or similar locations <2 months earlier, suggesting that the increased river flow in May moved coarse sediment from exposed sections of the sediment delta into the sampling region. Underflow density currents are common in Lake Powell (Johnson and Merritt 1979), and these may transport sediment along the lakebed after deposition. Subaqueous, $\leq$40-cm thick gravity flows can also move sediment along the reservoir floor, especially in the delta region (Pratson et al. 2008).

Implications. Particle size trends in Lake Powell are important because our data show that they correspond to significant variations in sediment mineralogy and chemistry. Thus, the substantial chemical load associated with suspended sediment in the Colorado and San Juan Rivers (Horowitz et al. 2001) is deposited in the lower regions of their respective deltas, an observation consistent with previous data collected at Lake Powell (Hart et al. 2005). Conversely, the upper regions of the deltas (and the side canyons) are comparatively lower in trace elements.

Since 2000, the Colorado River Basin has experienced a drought that has drawn Lake Powell down ≤44 m (USBR 2008). This process exposes delta sediment, which is then resuspended by the rivers and deposited further into the smaller lake (Vernieu 1997, Pratson et al. 2008). Sediment resuspension can release contaminants into ecosystems (Castelle et al. 2007), and the recent removal of a 4-m dam in North Carolina, USA led to release of carbon and nitrogen from resuspended reservoir sediment (Riggsbee et al. 2007).

In Lake Powell, quarterly water quality monitoring data show an abrupt increase in summertime total chlorophyll concentration during hydrologic year 2003 in surface water collected 193.3, 208.5, and 225.5 km from GCD (Figure 3; Vernieu, in preparation). Primary productivity in Lake Powell is limited by P (Gloss et al. 1980), so an increase in chlorophyll implies that an additional source of P entered the upper region of Lake Powell. Our data show that P is highly significantly correlated with particle size, organic carbon, and calcite, significantly correlated with several clay minerals, and highly significantly anticorrelated with quartz and feldspar, in agreement with previous work relating P to particle size (Blecker et al. 2006) and clays (Borgnino et al. 2006). Therefore, elevated chlorophyll may have been caused by P release during resuspension of fine sediment. The data presented here do not prove this connection; ongoing research will quantify the release of P during resuspension of Lake Powell sediment.

Importantly, chlorophyll does not increase when reservoir drawdown begins; rather, it occurs ~3 years later. Since the current drought followed a period of steady and high reservoir levels during the late 1990s, the initial drawdown should have led to resuspension of sandy sediment in the upper regions of the deltas, which our findings show are low in carbon and inorganic chemicals. The resuspension of fine particles would not have occurred until the lake was low enough to expose the lower portions of the deltas. This may explain the delay in the response of chlorophyll concentrations. If correct, it suggests that a slight drawdown has little effect on nutrient release from sediments, but a lake level threshold exists below which the resuspension of fine sediments begins and water quality can be affected. This is particularly important at Lake Powell, where the decay of this additional biomass may have contributed to a parcel of water low in dissolved oxygen (DO) that persisted below the thermocline in summer 2005 and passed through GCD that autumn. The subsequent DO concentrations of 3-4 mg L^{-1} in dam releases impaired a fishery near Lees Ferry, Arizona, ~25 km below GCD (Vernieu, in preparation).

Climate change may lead to substantial changes and variations to the hydrographs of Western United States rivers (Barnett et al. 2008), which may lead to the extreme drawdown of Lake Powell (Barnett and Pierce 2008). Our results link the concentration of chemicals in the sediment of this reservoir to sediment particle size and show that spatial trends of particle size exist in the long, narrow Colorado River delta. A similar trend probably exists in the San Juan River delta, also, and these trends raise the possibility that extreme reservoir drawdown can impair reservoir and downstream water quality. This possibility suggests that reservoir managers should consider water quality in addition to hydropower production, downstream needs, and recreation when optimizing yearly dam release plans.

Future Work. This study can serve as the start of many distinct and interesting avenues of future research; three examples will be discussed here. First, a detailed mineralogical investigation using electron microscopy would allow quantification of the shape of small particles, which would give insight into their surface area and their ability to sorb water or chemicals. Also, electron microscopy would allow a better determination of the ratio of oxide minerals to calcite, which form in different environmental conditions. This would enable a statement regarding which of these is the primary sorbent of elements like P.

The varying concentrations of carbon in the Colorado River Delta of Lake Powell could lead to a study of carbon degradation in delta settings. Lake Powell would be a particularly useful setting because of the long, narrow shape of the delta and the reliable measurements of river inflow. Such a study could include careful dating and reconstruction of depositional patterns in the delta. Samples would be collected, extracted with organic solvents, and analyzed by gas chromatography-mass spectrometry to determine variations in the concentrations of individual carbon compounds as functions of depth and spatial distribution in the delta.

Finally, the association of trace elements with sediment particles of varying size may reflect the composition of the source rocks upstream, or it may be the result of sorption of dissolved trace elements to particles during riverine transport. These two influences could be separated by determining the composition of representative source rocks in the Southern Rocky Mountains and the Colorado Plateau and calculating an average weighted to the erosion of these rocks in the watershed. This average would be compared to the molar ratios presented in this study. This comparison could be bolstered by sampling suspended sediment in the catchments of the various source rock types to verify that the composition of eroded sediment matches that of rocks in formations. This final step may be an operational way of accounting for *in situ* chemical weathering and should be compared to theoretical calculations.

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Figure 1

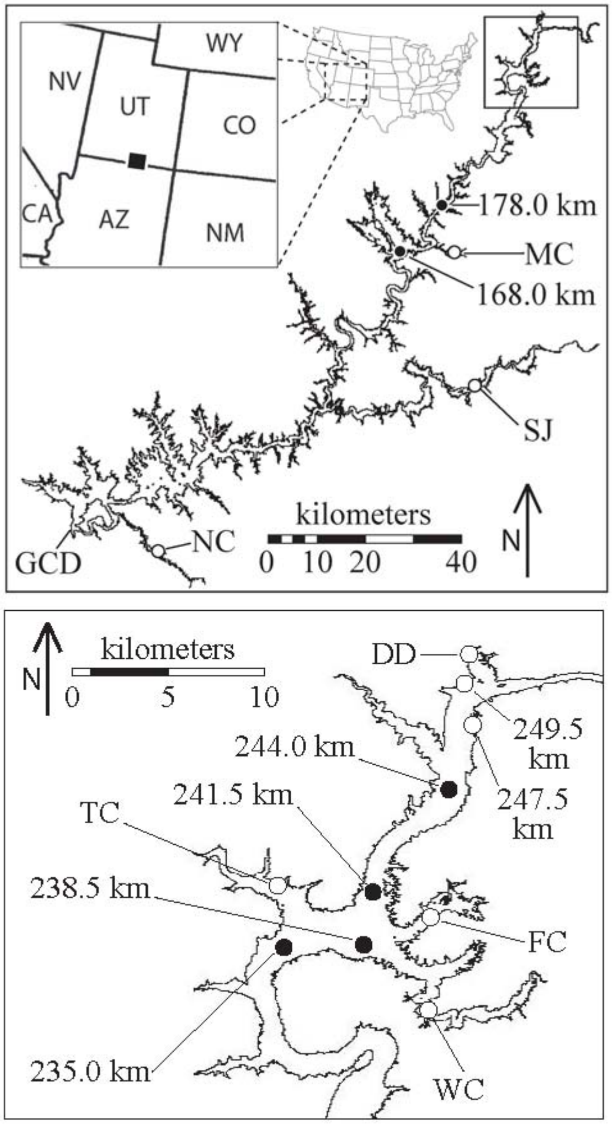

Figure 1. Sampling locations at Lake Powell. White and black circles represent shoreline and lakebed sampling sites, respectively. *Upper panel:* Side canyon sampling sites Navajo Canyon (NC), Moqui Canyon (MC), and the San Juan River (SJ) and lakebed sampling sites 168.0 and 178.0 river km from Glen Canyon Dam (GCD). The box in the northern portion of the lake delineates the inflow region. *Lower panel:* Side canyon sampling sites White Canyon (WC), Farley Canyon (FC), the Dirty Devil River (DD), delta shoreline sites 249.5 and 247.5 km from GCD, and lakebed sampling sites 235.0, 238.5, 241.5, and 245.0 km from GCD.

Figure 2

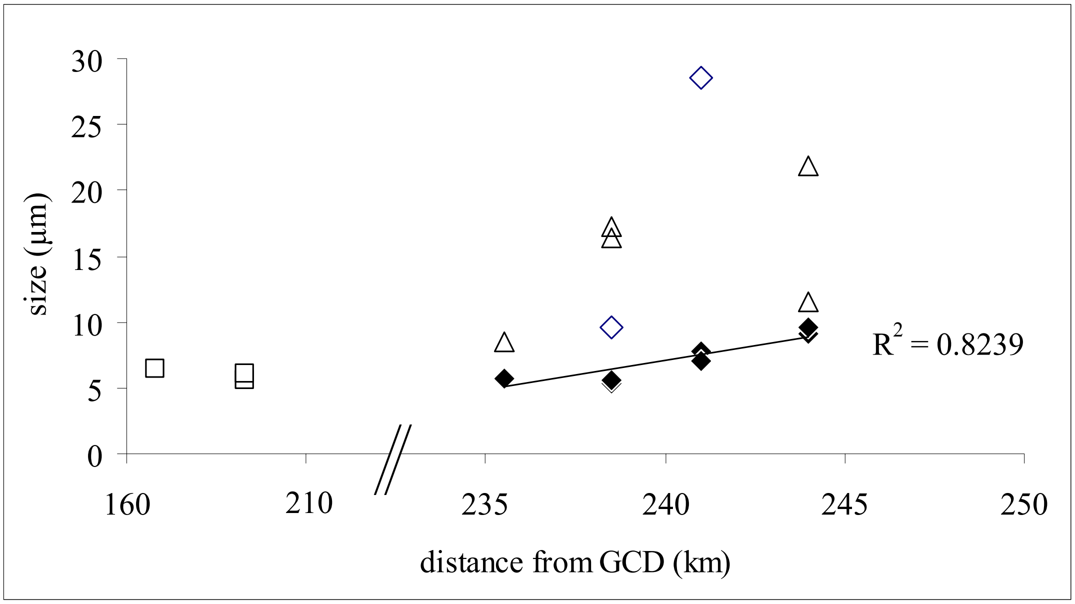

Figure 2. Particle size of lakebed sediment in Lake Powell: delta surface samples, March (♦), delta surface samples, May (◇), mid-lake surface samples (□), and delta deep samples, March (△). The trendline and the R^2 value apply only to the delta surface samples from March.

Figure 3

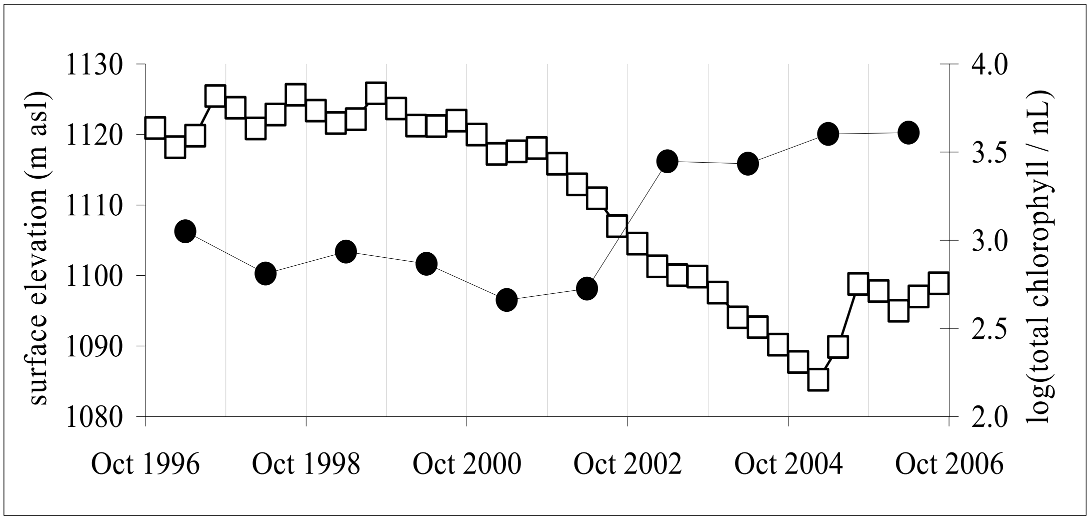

Figure 3. Possible impact of drawdown on water quality, hydrologic years 1997-2006: lake surface elevation (□), logarithm of average summertime chlorophyll (●). The surface elevation parameter is a quarterly average of daily lake elevation measurements (USBR 2008). The chlorophyll parameter is an average of 6 data points, two summertime sampling times (typically May and August or June and October) at 193.3, 208.5, and 225.5 km from Glen Canyon Dam (from Vernieu, in preparation).

Supporting Information for

Particle size controls sedimentary chemical distribution in a large reservoir, Lake Powell, USA.

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(In preparation for *Environmental Science and Technology*)

Section S1: Sedimentation in Lake Powell. Lake Powell receives most of its sediment from its two main tributaries, the Colorado and San Juan Rivers. The Colorado River drains consists of a mixture of sediment from the Colorado and Green Rivers (and their many tributaries), which together flow well over 1500 km before reaching Lake Powell. These drain the southern Rocky Mountains, which are formed by a variety of limestones, igneous, and metamorphic formations, and the northeastern Colorado Plateau, which is mostly sandstones and mudstones with some basalt (Spahr et al. 2000; Anderson et al. 2003). Land use upstream from Lake Powell includes agriculture, mining, ranching, logging, recreational uses, and limited urban activity (Spahr et al. 2000). Conversely, the side canyons of Lake Powell drain sedimentary rock almost exclusively and a single formation often. Lake Powell is contained within Glen Canyon National Recreation Area and surrounded by remote desert, so there is exceedingly sparse human presence in the side canyon drainages away from the lake.

In the Colorado River inflow region of the reservoir, the river brings an uninterrupted, yet seasonally variable, sediment supply. At a given lake level, sediment is thought to settle out over ~25 km (S. B. Hueftle, Grand Canyon Monitoring and Research Center, personal communication, 2005), yet our monitoring observations suggest that the

Colorado River sediment delta is spread out as much as 100 km due to varying lake level and bedload transport. After sediment is deposited, it is reasonable to expect that preferential re-entrainment of small particles (i.e., winnowing) may occur near the river inflow when energetic flows reach the sediment, though we are not aware of any studies on this process in Lake Powell. This process should transport small particles further into the reservoir than large particles, exaggerating sediment sorting that we expect during initial sedimentation in the inflow region. Although we can not discount the possibility of winnowing, we expect it to be a minor effect in the upper area of the inflow region, which is dominated by the deposition of riverine suspended sediment.

As opposed to the main river deltas, intermittent desert creeks feed the side canyons. In this setting, nearly all of fine sediment and the majority of coarse sediment can be expected to be transported in short-duration, high-energy, "flash" floods (Malmon et al. 2004, Dick et al. 1997, US NWS 2008). We have observed this firsthand in the study area (Chapter 3). The sediment loads deposited in the side canyons are spatially distinct from one another because they are confined to separate creekbeds. While they occasionally spill into the thalweg of the reservoir, their sediment load is much smaller and intermittent than that of the Colorado River, whose sediment delta is not expected to contain meaningful amounts of side canyon sediment.

Section S2: Particle size analysis. Before particle size analysis, 0.04-0.5 g of dry sediment was shaken in 5.5 g L^{-1} sodium hexametaphosphate for ≥4 h. Samples were allowed to settle until analysis, and then shaken vigorously by hand to resuspend particles. Particle size was analyzed with a Mastersizer 2000 laser diffractometer (Malvern

Instruments Ltd., Worcestershire, UK). The sample-solution ratio was adjusted so that most samples were analyzed with an obscuration of 20 ± 4% (Sperazza et al. 2004). Samples were stirred at a rate of 1750 rotations per minute and ultrasonicated while in the sample introduction chamber (~2.5 min). To collect each particle size distribution, 1000 readings per second were collected for 10 seconds, and data were compiled with the Mastersizer 2000 computer program (version 5.22, Malvern Instruments Ltd., Worcestershire, UK) using a particle absorbance index of 1.0 and a refractive index of 1.52 (Sperazza et al. 2004). Five analytical replicates of each subsample were analyzed and averaged. Most sediment samples were subsampled in triplicate to compensate for any inhomogeneities due to the small sample mass. Variation between triplicate samples was small, so sample replicates were averaged.

Section S3: Elemental abundance measurements. Elemental abundances of a suite of elements were measured in samples with a XEPOS energy dispersive X-ray fluorescence (XRF) spectrometer (Spectro Analytical Instruments, Inc., Mahwah, NJ). Before analysis, samples were milled to a median particle size of < 100 µm in polypropylene tubes with zirconium oxide milling balls. Milled sample was mixed with binder wax (Licowax C Micropowder PM, APC Solutions SA) at a ratio of 4 g sample to 1.1 g wax and pressed into a pellet at a pressure of 15 tons for 2 min. Samples were analyzed on the XEPOS using a 50 W Pd tube and several polarizing/secondary targets for optimized excitation (see below). The measurement was carried out under vacuum (pressure <60 Pa) to prevent absorption of the characteristic radiation of the light elements (Na - Ti) in air. The fluorescent radiation was recorded using a high count rate Silicon Drift Detector and analyzed via a general purpose standardless calibration package (TurboQuant Pellets) based on fundamental parameters and matrix-correction via Compton-peak analysis (provided by Spectro Analytical Instruments, Inc., Mahwah, NJ).

For optimized excitation and detection limits, each sample was irradiated for 5 minutes from each of the following targets: a curved highly oriented pyrolithic graphite target (HOPG), producing polarized quasi-monochromatic Pd-L X-rays for the excitation of 22 (Na) to 51 (V), a molybdenum secondary target for optimized excitation of the K-lines of 52-91 (Cr-Zr) and the L-lines of 141-238 (Pr-U), and an Al2O3 Barkla scatterer target, providing polarized Bremsstrahlung (deceleration radiation in a continuous spectrum) for the elements 89-140 (Y-Ce). To judge the accuracy of this measurement, certified standards NIST 2709 (National Institute of Standards and Technology) and TILL-1 (Canadian Certified Reference Materials Project) were analyzed. These standards were selected because the Compton scatter peaks (an indication of the average atomic number in the sample) matched those of the Lake Powell samples most closely, implying that matrix effects would be similar between these standards and the unknowns. Errors were below 20% for Mg, Al, Si, K, Ca, Ti, Mn, Fe, Ni, Cu, Zn, Ga, As, Br, Sr, Y, Ba, Pb, and Th. Errors exceeded 20% for P, V, Ce. The inaccuracies for the latter list of elements are, however, expected to be a systematic variation (a matrix-dependent constant scaling factor) rather than random variation, thus consistent comparison between samples is possible for these elements. Detection limits of the XEPOS vary by element and are ≤0.0001% (1 ppm) for most elements (as specified by the manufacturer for similar matrices). Concentrations of Ge, Nb, Mo, Ag, Cd, In, Sn, Sb, Te, I, Hf, Ta, W, Hg, and Tl, were consistently below detection limits, so these elements are not included in this study.

Cobalt data were rejected due to overlap of its spectroscopic peak with that of Fe, which occurred in much larger concentrations. Analytical precision was excellent; relative standard deviations were <5% for elements with concentrations consistently above the detection limit.

Eight to ten analytical replicates were measured for 17 samples, and the detection limit for each element was set at 3 times the average standard deviation of these replicate analyses

Section S4: Carbon measurements. Carbonate minerals were extracted from sediment samples by treating 0.5 g of each sample with two washes of 15 mL 1 N hydrochloric acid followed by a water wash and freeze-drying (Hedges and Stern 1984, White et al. 2005, Longworth et al. 2007, ASTM 2008). These samples and untreated sediment samples were analyzed on the elemental analyzer using an 8-point acetanilide calibration and a detection limit of 0.02%.

Section S5: Mineralogical measurements. Samples were prepared for mineralogical analyses by grinding 1 g of sample and 4 g methanol with corundum (Al_2O_3) milling weights. After drying overnight at 90°C, ground samples were mixed with 0.111 g zincite (ZnO), which was used as an internal standard. Samples were analyzed on the X-ray diffractometer using Cu Kα radiation over a 2θ range of 5-65°, a step interval of 0.02°, and duration of 2 s $step^{-1}$. Mineral concentrations in each sample were created from linear combinations of several previously-analyzed standards as described by Eberl (2003). Deviation of the sum of mineral concentrations from 100% gives an indication of error in the measurement.

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Tables

Table S1: Sampling locations.

location[a]	number of cores	latitude	longitude	water depth (m)	collection date
Lakebed Samples, March 2006					
244.0	2	37.8455	-110.4236	1.2	21-23 March 2006
241.0	2	37.8244	-110.4363	6.7	21-23 March 2006
238.5	2	37.8067	-110.4334	19.1	21-23 March 2006
235.5	2	37.8106	-110.4674	27.7	21-23 March 2006
168.0	1	37.4580	-110.7277	72.5	21-23 March 2006
Lakebed Samples, May 2006					
241.0	1	37.8151	-110.4324	22.1	16-18 May 2006
238.5	1	37.8099	-110.4676	30.2	16-18 May 2006
193.0	2	37.5807	-100.5984	68.8	16-18 May 2006
Delta Shoreline Samples					
249.5	1	37.8873	-110.4003		21 March 2006
247.5 A	1	37.8734	-110.4050		12 April 2005
247.5 B	2	37.8734	-110.4050		18 June 2005
247.5 C	2	37.8734	-110.4050		05 December 2005
Side Canyon Samples					
DD	1	37.9029	-110.3973		16-18 May 2006
FC A	1	37.8193	-110.4120		16-18 May 2006
FC B	3	37.8188	-110.4122		27 March 2007
WC A	4	37.7926	-110.4136		07 February 2005
WC B	2	37.7947	-110.4133		13 April 2005
WC C	3	37.7839	-110.4044		19 June 2005
WC D	3	37.7867	-110.4065		05 December 2005
WC E	3	37.7853	-110.4083		27 March 2007
TC A	1	37.8276	-110.4738		21-23 March 2006
TC B	1	37.8276	-110.4738		16-18 May 2006
MC	1	37.4732	-110.6162		22 June 2005
SJ	3	37.2640	-110.4623		21 June 2005
NC A	1	36.8780	-111.2389		20 June 2005
NC B	2	36.8756	-111.2382		20 June 2005

[a] Numbers indicate distance from Glen Canyon Dam rounded to nearest 0.5 km. Letters indicate abbreviations of side canyons for Dirty Devil River (DD), Farley Canyon (FC), White Canyon (WC), Trachyte Canyon (TC), Moqui Canyon (MC), San Juan River (SJ), and Navajo Canyon (NC).

Table S2: Particle size statistics.

location[a]	depth (cm)	median (μm)	mean (μm)	mode (μm)
Lakebed Samples, March 2006				
244.0	0-5	6.09	9.07	9.77
244.0	0-16	6.39	9.54	10.20
244.0	15-30	7.56	11.59	12.69
244.0	60-75	6.90	21.84	44.60
241.2	0-5	4.67	7.03	4.96
241.2	0-12.5	5.15	7.80	6.57
238.7	0-12.5	3.80	5.38	3.69
238.7	0-15	3.97	5.56	4.11
238.7	25-40	11.00	16.45	17.81
238.7	40-50	12.66	17.27	19.23
235.4	0-15	3.90	5.69	3.68
235.4	0-15	3.93	5.73	3.73
235.4	25-40	5.74	8.48	7.36
168.0	5-15	3.78	6.38	2.67
Lakebed Samples, May 2006				
241.2	5-15	21.10	28.55	40.52
238.7	0-5	6.47	9.55	8.84
193.3	0-15	3.79	5.54	3.49
193.3	0-15	4.11	6.11	3.86
Delta Shoreline Samples				
247.5 A	0-8	133.53	141.32	154.55
247.5 B	0-10	119.19	122.30	135.67
247.5 B	0-8	131.42	135.54	146.49
247.5 C	0-8	30.92	41.93	45.60
247.5 C	0-16	18.29	20.32	26.36
249.5	-132 to -122	15.14	21.49	33.47
249.5	-102 to -94	264.12	291.87	272.47
249.5	-94 to -87	276.10	304.77	283.90
249.5	-77 to -67	290.96	297.94	327.74
249.5	-57 to -47	308.36	322.28	319.83
249.5	-47 to -37	6.41	10.30	8.17
249.5	-12 to -2	6.15	10.35	7.69
249.5	14 to 20	7.64	27.61	73.11
Side Canyon Samples				
FC A	0-12	49.97	51.95	57.23
FC A	17.5-27.5	59.99	62.20	66.89
FC A	42.5-52.5	53.61	55.20	63.78
FC A	57.5-67.5	66.82	69.06	74.75

Table S2: Particle size statistics, continued.

location[a]	depth (cm)	median (µm)	mean (µm)	mode (µm)
FC B	0-4	53.16	55.03	61.55
FC B	0-8	84.94	95.01	92.85
FC B	0-8	84.98	95.28	92.20
FC B	16-24	97.16	110.08	110.10
FC B	16-24	106.79	122.63	123.17
WC A	0-12	78.24	81.94	90.84
WC B	0-8	80.67	92.65	88.26
WC B	0-8	62.35	68.89	71.96
WC C	0-8	18.67	70.44	188.56
WC D	30-44	402.01	444.50	408.34
WC E	0-4	140.54	148.20	159.70
WC E	0-8	178.36	186.60	198.00
WC E	16-24	106.58	114.71	118.10
WC E	16-24	112.68	117.73	126.24
TC A	10-20	40.76	43.92	58.27
TC A	35-45	36.69	46.92	50.41
TC A	80-90	141.62	150.08	149.54
TC A	123-133	35.46	39.04	45.22
TC A	165-175	135.80	143.65	145.47
TC A	187.5-197.5	184.95	198.32	244.31
MC	0-8	115.60	120.04	123.49
SJ	0-8	96.32	100.96	110.10
SJ	0-6	77.38	81.80	106.62
NC A	0-12	157.99	167.92	163.01
NC B	0-8	107.27	115.14	128.50

[a] "Location" refers to distance from Glen Canyon Dam (in river km) for delta samples and to side canyon location.

Table S3A: Elemental abundances (%) in sediment samples.

sample description		*element*										
location[a]	depth (cm)	org C	tot C	Mg	Al	Si	P	S	Cl	K	Ca	Ti
Lakebed Samples, March 2006												
245.0	0-5	1.03	2.59	1.747	6.301	22.030	0.057	0.042	0.008	1.942	5.782	0.359
245.0	0-16	1.19	2.67	1.822	6.657	22.640	0.059	0.055	0.018	2.041	6.029	0.374
245.0	15-30	1.42	2.94	1.969	7.323	24.950	0.069	0.061	0.017	2.154	6.322	0.381
245.0	60-75	0.96	2.85	1.787	6.538	22.760	0.060	0.047	0.012	2.026	5.921	0.362
241.0	0-5	1.03	2.53	1.688	7.200	23.010	0.058	0.048	0.015	2.032	5.109	0.369
241.0	0-12.5	0.97	2.72	1.872	7.552	24.510	0.065	0.049	0.022	2.200	5.674	0.392
238.5	0-12.5	0.87		1.719	7.677	23.860	0.062	0.045	0.007	2.288	4.777	0.378
238.5	0-15			1.623	7.217	22.640	0.057	0.043	0.008	2.197	4.719	0.365
238.5	25-40	1.18	3.14	1.863	6.752	25.030	0.072	0.070	0.009	1.968	6.737	0.364
238.5	40-50	1.10	3.15	1.833	6.440	25.300	0.074	0.073	0.011	1.958	6.903	0.369
235.5	0-15	0.86	2.31	1.859	8.134	26.503	0.064	0.041	0.011	2.476	5.380	0.433
235.5	0-15	0.94	2.37	1.590	6.935	22.563	0.056	0.035	0.009	2.069	4.754	0.368
235.5	25-40	0.97	2.65	1.802	7.717	25.661	0.070	0.056	0.012	2.224	5.585	0.397
168.0	5-15	1.07	2.66	1.661	7.960	24.943	0.074	0.079	0.011	2.018	5.398	0.374
Lakebed Samples, May 2006												
241.0	5-15	1.23		1.396	4.695	24.290	0.062	0.070	0.008	1.694	5.584	0.277
238.5	0-5	1.27	2.89	1.664	6.650	22.980	0.063	0.070	0.014	1.996	5.639	0.372
193.0	0-15	0.90	8.55	1.576	6.883	22.790	0.057	0.034	0.008	2.036	4.855	0.360
Delta Shoreline Samples												
249.5	-132 to -122		2.49	1.697	6.291	25.597	0.061	0.053	0.009	2.046	6.083	0.357
249.5	-102 to -94	0.05	1.25	0.678	2.716	34.360	0.025	0.007	0.007	1.481	3.320	0.119
249.5	-94 to -87	0.03	1.34	0.833	3.087	31.950	0.037	0.019	0.006	1.535	3.997	0.144
249.5	-77 to -67	0.06	0.71	0.819	2.992	31.900	0.032	0.033	0.009	1.467	3.737	0.131
249.5	-57 to -47	0.07	0.68	0.716	2.910	31.260	0.028	0.015	0.008	1.493	3.929	0.123
249.5	-47 to -37	1.01	2.70	1.508	6.327	22.535	0.059	0.051	0.007	1.958	5.306	0.358
249.5	-12 to -2	1.01	2.58	1.426	6.033	21.325	0.056	0.045	0.008	1.867	5.251	0.336
249.5	14 to 20			1.533	6.602	23.240	0.062	0.048	0.006	1.977	5.313	0.340

Table S3A (continued): Elemental abundances (%) in sediment samples.

sample description							*element*					
location[a]	depth (cm)	org C	tot C	Mg	Al	Si	P	S	Cl	K	Ca	Ti
247.5 A	0-8	0.06	1.02	0.796	2.929	34.070	0.033	0.013	0.019	1.567	3.665	0.159
247.5 B	0-8	0.16	1.30	0.908	3.408	32.190	0.041	0.014	0.015	1.692	3.997	0.162
247.5 B	0-10	0.12	1.02	0.901	3.331	33.440	0.038	0.009	0.007	1.662	3.810	0.150
247.5 C	0-8	3.70	4.50	1.542	5.800	24.540	0.069	0.180	0.015	1.893	5.728	0.310
247.5 C	0-16	5.26	5.59	1.482	5.492	25.540	0.079	0.144	0.011	1.883	5.622	0.296
247.5 C	14-24	1.31	2.64	1.335	4.835	26.677	0.059	0.097	0.011	1.878	5.485	0.251
Side Canyon Samples												
DD[c]	0-10		1.44	0.972	2.487	22.720	0.038	0.056	0.019	1.335	5.012	0.178
DD	20-30		2.17	1.124	3.285	22.730	0.046	0.101	0.014	1.493	6.093	0.210
DD	47-57		3.44	0.563	1.376	19.100	0.015	0.026	0.013	0.997	3.185	0.104
DD	57-67		1.90	1.209	3.154	22.150	0.055	0.078	0.063	1.460	6.148	0.213
DD	77-87	0.78		1.499	4.485	21.310	0.052	0.075	0.016	1.721	7.580	0.293
DD	102-122	0.22	1.89	1.358	4.327	21.630	0.047	0.073	0.014	1.587	5.578	0.227
DD	130-140		1.72									
DD	167.5-177.5		3.13									
DD	180-190	0.84	2.68	1.402	5.060	20.140	0.051	0.059	0.007	1.630	6.087	0.305
DD	195-205		3.31									
FC A	0-12	0.23	1.37	1.337	4.875	23.730	0.027	0.205	0.021	2.215	3.650	0.303
FC A	12-17			0.991	4.172	24.000	0.025	0.019	0.009	1.994	2.916	0.270
FC A	17.5-27.5	0.09	1.14									
FC A	42.5-52.5	0.15	1.28	1.343	5.835	22.360	0.033	0.038	0.013	2.328	3.548	0.310
FC A	57.5-67.5	0.08	1.09	1.237	4.324	31.640	0.013	0.013	0.015	2.404	3.124	0.255

Table S3A (continued): Elemental abundances (%) in sediment samples.

sample description								*element*				
location[a]	depth (cm)	org C	tot C	Mg	Al	Si	P	S	Cl	K	Ca	Ti
FC B	0-4	0.23	1.59	1.462	4.618	31.110	0.023	0.024	0.014	2.443	3.697	0.309
FC B	0-8	0.07	1.30	1.305	3.398	31.995	0.020	BDL	0.008	2.021	4.118	0.231
FC B	0-8	0.06	1.28	1.257	3.331	32.564	0.025	0.006	0.009	2.018	4.033	0.232
FC B	4-8	0.06	1.27									
FC B	8-12	0.08	1.31									
FC B	8-16	0.06	1.46									
FC B	8-16	0.05	1.38									
FC B	12-16	0.08	1.50									
FC B	16-20	BDL	1.28									
FC B	16-24	0.05	1.35	1.276	3.200	32.200	0.014	0.00020	0.014	1.933	4.362	0.211
FC B	16-24	0.05	1.62	1.308	3.392	31.280	0.019	0.00020	0.019	1.980	4.571	0.220
FC B	20-24	0.08	1.75									
FC B	24-28	0.05	1.51									
FC B	24-32	0.05	1.79									
FC B	24-32	0.04	2.41									
FC B	28-32	0.04	1.45									
FC B	32-36	0.04	1.41									
WC A	0-10		3.79									
WC A	0-10			1.610	4.124	28.120	0.026	0.036	0.011	2.037	5.502	0.237
WC A	0-12	0.31	2.57	1.504	3.299	30.750	0.034	0.004	0.007	1.870	4.843	0.208
WC A	0-14	0.38	2.14	1.371	2.814	30.940	0.030	0.015	0.009	1.630	4.767	0.187
WC B	0-8	0.12	1.78	1.488	3.111	31.850	0.023	0.007	0.006	1.765	4.780	0.207
WC B	0-8	0.19	1.86	1.567	3.557	31.020	0.028	0.004	0.006	1.921	4.966	0.247
WC C	0-8	0.64	2.21	1.813	8.229	23.604	0.041	0.119	0.032	2.758	5.552	0.405
WC C	0-10	0.56	2.64	1.739	7.962	24.090	0.039	0.055	0.023	2.759	5.207	0.418
WC C	4-6			1.545	7.632	20.160	0.031	0.079	0.010	2.796	4.377	0.402
WC C	10-12			1.428	7.042	19.320	0.036	0.113	0.012	2.514	4.429	0.373
WC C	20-22			0.736	2.020	19.300	0.013	0.077	0.017	1.065	3.353	0.122

Table S3A (continued): Elemental abundances (%) in sediment samples.

sample description				*element*								
location[a]	depth (cm)	org C	tot C	Mg	Al	Si	P	S	Cl	K	Ca	Ti
WC D	0-10	0.08	1.16									
WC D	0-10	0.12	1.56	1.342	2.782	31.490	0.031	0.008	0.010	1.398	4.391	0.199
WC D	0-11	0.12	2.01	1.314	2.560	32.630	0.006	0.001	0.005	1.346	4.373	0.176
WC D	30-44	0.03	1.14	0.971	1.110	32.860	0.014	0.006	0.008	0.871	4.665	0.103
WC E	0-4	BDL	1.28	1.241	1.973	33.960	0.00062	0.003	0.018	1.351	3.919	0.129
WC E	0-8			1.146	1.619	34.090	0.00067	0.004	0.009	1.179	3.748	0.118
WC E	0-8	0.05	1.18	1.217	1.898	33.790	0.001	0.003	0.008	1.281	3.953	0.131
WC E	4-8	0.05	0.99									
WC E	8-12	0.03	1.01									
WC E	8-16	0.10	1.41									
WC E	12-16	0.04	0.97									
WC E	16-20	0.03	1.34									
WC E	16-24			1.296	2.531	32.620	0.016	0.003	0.011	1.603	4.062	0.170
WC E	16-24	0.11	1.47	1.289	2.416	32.590	0.010	0.005	0.011	1.569	4.020	0.141
WC E	20-24	0.07	1.18									
WC E	24-28	0.03	1.31									
WC E	28-32	0.11	1.51									
TC A[c]	10-20	4.63	6.19	0.966	5.014	24.819	0.083	0.053	0.008	1.805	4.034	0.273
TC A	35-45	12.82	16.85	0.934	3.795	17.028	0.096	0.126	0.007	1.323	4.962	0.208
TC A	80-90	0.05	1.01	0.644	1.962	26.520	0.011	BDL	0.006	1.186	2.706	0.102
TC A	123-133	7.16	16.65	1.062	4.811	22.510	0.099	0.120	0.007	1.702	4.644	0.288
TC A	165-175	0.04	0.85	0.683	2.027	23.900	0.011	0.004	0.007	1.242	2.886	0.092
TC A	187.5-197.5	0.57	1.23	0.664	2.241	19.510	0.026	0.072	0.008	1.073	2.953	0.094
TC A	205-215		0.77									
TC B[c]	7.5-17.5	0.24	0.90	0.770	2.640	22.020	0.030	0.017	0.006	1.362	3.574	0.131
TC B	33-43		0.78	0.612	1.816	36.660	0.011	BDL	0.006	1.173	2.626	0.099
TC B	50-58		6.06	0.845	4.590	18.880	0.102	0.129	0.010	1.429	4.024	0.244
MC	0-8	0.60	0.29	0.706	2.191	37.160	BDL	0.036	0.009	1.848	1.150	0.107

Table S3A (continued): Elemental abundances (%) in sediment samples.

sample description				*element*								
location[a]	depth (cm)	org C	tot C	Mg	Al	Si	P	S	Cl	K	Ca	Ti
SJ	0-5			1.035	5.099	30.680	0.023	0.027	0.004	1.801	3.609	0.290
SJ	0-6	0.26		0.867	4.288	33.130	0.018	0.026	0.007	1.809	3.160	0.244
SJ	0-8	0.04	0.63	0.743	3.310	34.360	0.008	0.048	0.030	1.775	2.769	0.216
SJ	10-15			0.972	4.446	31.580	0.021	0.015	0.006	1.869	3.555	0.255
SJ	20-25			0.723	3.570	32.130	0.007	0.011	0.003	1.790	2.869	0.195
SJ	30-35			0.679	3.269	33.260	0.014	0.004	0.004	1.731	2.521	0.194
NC A	0-12	BDL	0.19	0.470	1.364	37.920	0.013	BDL	0.010	1.511	0.986	0.090
NC B	0-8	0.16	0.61	0.905	2.904	36.090	0.004	0.015	0.010	1.963	2.150	0.160
NC B	0-12	0.31	0.89	1.206	3.689	31.970	0.033	0.074	0.005	2.055	2.719	0.175
median crustal abundance[b]				2.33	8.23	28.2	0.105	0.0350	0.0145	2.09	4.1500	0.565

sample description				*element*								
location[a]	depth (cm)	V	Cr	Mn	Fe	Ni	Cu	Zn	Ga	As	Se	Br
Lakebed Samples, March 2006												
245.0	0-5	0.017	0.006	0.057	2.973	0.002	0.003	0.009	0.0016	0.0010	BDL	0.0004
245.0	0-16	0.014	0.007	0.062	3.085	0.002	0.003	0.009	0.0016	0.0010	0.0001	0.0005
245.0	15-30	0.012	0.007	0.059	2.934	0.002	0.002	0.009	0.0015	0.0010	0.0001	0.0005
245.0	60-75	0.014	0.007	0.053	2.898	0.002	0.003	0.009	0.0016	0.0010	0.0001	0.0003
241.0	0-5	0.016	0.007	0.051	3.214	0.002	0.003	0.010	0.0020	0.0011	0.0001	0.0005
241.0	0-12.5	0.015	0.009	0.056	3.286	0.002	0.003	0.010	0.0019	0.0010	0.0002	0.0005
238.5	0-12.5	0.018	0.006	0.051	3.364	0.002	0.003	0.010	0.0020	0.0011	0.0001	0.0003
238.5	0-15	0.017	0.006	0.051	3.299	0.002	0.003	0.010	0.0019	0.0010	0.0001	0.0003
238.5	25-40	0.016	0.006	0.063	2.749	0.002	0.002	0.009	0.0014	0.0008	0.0001	0.0003
238.5	40-50	0.014	0.004	0.064	2.610	0.002	0.002	0.008	0.0012	0.0009	0.0001	0.0003
235.5	0-15	0.022	0.006	0.054	3.352	0.002	0.003	0.010	0.0018	0.0008	0.0001	0.0003
235.5	0-15	0.018	0.006	0.053	3.249	0.002	0.003	0.010	0.0018	0.0009	0.0001	0.0003
235.5	25-40	0.018	0.007	0.059	3.216	0.002	0.003	0.011	0.0018	0.0010	0.0001	0.0004
168.0	5-15	0.018	0.007	0.040	2.884	0.003	0.002	0.010	0.0019	0.0007	0.0001	0.0003

Table S3A (continued): Elemental abundances (%) in sediment samples.

sample description		*element*										
location[a]	depth (cm)	V	Cr	Mn	Fe	Ni	Cu	Zn	Ga	As	Se	Br
Lakebed Samples, May 2006												
241.0	5-15	0.006	0.003	0.042	1.739	0.002	0.002	0.006	0.0009	0.0005	BDL	0.0003
238.5	0-5	0.016	0.007	0.060	3.075	0.002	0.003	0.010	0.0017	0.0009	0.0001	0.0005
193.0	0-15	0.017	0.006	0.053	3.224	0.002	0.003	0.010	0.0016	0.0010	0.0001	0.0003
Delta Shoreline Samples												
249.5	-132 to -122	0.011	0.006	0.048	2.319	0.002	0.002	0.007	0.0013	0.0008	0.0001	0.0002
249.5	-102 to -94	0.002	BDL	0.022	0.732	0.000	0.001	0.002	0.0006	0.0003	BDL	0.0001
249.5	-94 to -87	0.004	BDL	0.027	0.980	0.000	0.000	0.003	0.0005	0.0003	BDL	0.0001
249.5	-77 to -67	0.003	0.013	0.027	0.969	0.000	0.001	0.003	0.0005	0.0005	0.0001	0.0001
249.5	-57 to -47	0.003	BDL	0.024	0.821	BDL	0.001	0.002	0.0006	0.0004	BDL	0.0001
249.5	-47 to -37	0.017	0.006	0.057	3.013	0.002	0.002	0.010	0.0017	0.0008	0.0001	0.0002
249.5	-12 to -2	0.015	0.007	0.051	2.826	0.002	0.003	0.009	0.0015	0.0007	0.0001	0.0003
249.5	14 to 20	0.015	0.005	0.050	2.767	0.002	0.003	0.009	0.0016	0.0008	0.0001	0.0003
247.5 A	0-8	BDL	BDL	0.025	0.800	0.000	0.001	0.002	0.0006	0.0003	BDL	0.0001
247.5 B	0-8	0.002	BDL	0.026	0.854	0.000	0.001	0.003	0.0008	0.0003	BDL	0.0001
247.5 B	0-10	0.004	BDL	0.024	0.839	0.001	0.001	0.002	0.0006	0.0003	BDL	0.0001
247.5 C	0-8	0.014	0.005	0.046	2.340	0.002	0.018	0.014	0.0013	0.0011	0.0001	0.0005
247.5 C	0-16	0.012	BDL	0.048	2.120	0.002	0.003	0.008	0.0011	0.0008	0.0001	0.0005
247.5 C	14-24	0.007	0.003	0.037	1.639	0.002	0.024	0.014	0.0008	0.0005	0.0001	0.0003

Table S3A (continued): Elemental abundances (%) in sediment samples.

sample description		*element*										
location[a]	depth (cm)	V	Cr	Mn	Fe	Ni	Cu	Zn	Ga	As	Se	Br
Side Canyon Samples												
DD[c]	0-10	0.003	0.021	0.029	0.935	0.000	0.001	0.002	0.0006	0.0003	0.0001	0.0001
DD	20-30	0.005	0.004	0.034	1.182	0.001	0.001	0.003	0.0006	0.0004	BDL	0.0001
DD	47-57	0.003	0.047	0.019	0.720	0.001	0.001	0.001	0.0003	0.0003	BDL	0.0001
DD	57-67	0.004	0.037	0.032	1.301	0.001	0.001	0.003	0.0008	0.0004	0.0000	0.0002
DD	77-87	0.006	0.006	0.048	1.879	0.001	0.002	0.005	0.0009	0.0006	0.0001	0.0001
DD	102-122	0.008	0.009	0.032	1.423	0.001	0.001	0.003	0.0008	0.0003	BDL	0.0001
DD	180-190	0.011	0.007	0.040	2.597	0.002	0.002	0.007	0.0013	0.0006	0.0001	0.0001
FC A	0-12	0.004	0.015	0.027	1.438	0.001	0.001	0.002	0.0008	0.0002	0.0001	0.0001
FC A	12-17	BDL	0.016	0.025	1.194	0.001	0.001	0.002	0.0008	0.0003	0.0001	0.0001
FC A	42.5-52.5	0.005	0.038	0.032	1.764	0.002	0.001	0.003	0.0008	0.0004	BDL	0.0001
FC A	57.5-67.5	BDL	0.004	0.026	0.977	0.001	0.001	0.002	0.0005	0.0003	BDL	0.0001
FC B	0-4	0.003	0.007	0.031	1.216	0.001	0.001	0.002	0.0008	0.0005	BDL	0.0001
FC B	0-8	BDL	0.002	0.031	0.929	0.001	0.001	0.002	0.0005	0.0003	BDL	0.0001
FC B	0-8	0.003	0.002	0.030	0.919	0.001	0.001	0.002	0.0005	0.0003	0.0001	0.0001
FC B	16-24	BDL	0.004	0.032	0.914	0.001	0.001	0.001	0.0005	0.0002	BDL	0.0001
FC B	16-24	BDL	BDL	0.033	0.888	0.001	0.001	0.002	0.0005	0.0004	BDL	0.0001
WC A	0-10	0.005	0.004	0.037	1.157	0.001	0.013	0.008	0.0005	0.0005	BDL	0.0002
WC A	0-12	BDL	BDL	0.032	0.808	0.001	0.001	0.002	0.0004	0.0002	0.0001	0.0001
WC A	0-14	BDL	BDL	0.030	0.758	0.001	0.001	0.002	0.0005	0.0002	BDL	0.0001
WC B	0-8	BDL	BDL	0.031	0.808	0.001	0.001	0.002	0.0004	0.0002	BDL	0.0001
WC B	0-8	BDL	0.003	0.034	0.972	0.001	0.001	0.002	0.0007	0.0003	BDL	0.0001

Table S3A (continued): Elemental abundances (%) in sediment samples.

sample description		*element*										
location[a]	depth (cm)	V	Cr	Mn	Fe	Ni	Cu	Zn	Ga	As	Se	Br
WC C	0-8	0.009	0.006	0.052	2.905	0.003	0.003	0.006	0.0016	0.0010	0.0001	0.0003
WC C	0-10	0.010	0.009	0.052	2.803	0.002	0.003	0.005	0.0016	0.0007	0.0001	0.0002
WC C	4-6	0.009	0.007	0.056	3.385	0.002	0.003	0.006	0.0019	0.0009	BDL	0.0002
WC C	10-12	0.014	0.004	0.044	3.369	0.003	0.004	0.007	0.0017	0.0011	0.0001	0.0004
WC C	20-22	BDL	0.002	0.020	0.578	0.000	0.001	0.001	0.0001	0.0001	BDL	0.0001
WC D	0-10	0.002	0.003	0.029	0.814	0.000	0.007	0.004	0.0003	0.0002	0.0000	0.0001
WC D	0-11	BDL	BDL	0.031	0.716	0.000	0.001	0.001	0.0003	0.0003	BDL	0.0001
WC D	30-44	BDL	BDL	0.028	0.501	0.000	0.008	0.003	0.0002	0.0003	BDL	0.0001
WC E	0-4	BDL	BDL	0.027	0.534	0.000	0.001	0.001	0.0004	0.0003	0.0001	0.0001
WC E	0-8	BDL	BDL	0.025	0.475	0.000	0.001	0.001	0.0002	0.0001	BDL	0.0001
WC E	0-8	BDL	BDL	0.025	0.548	0.000	0.001	0.001	0.0003	0.0002	BDL	0.0001
WC E	16-24	BDL	BDL	0.026	0.678	0.000	0.001	0.001	0.0004	0.0001	0.0000	0.0001
WC E	16-24	BDL	BDL	0.027	0.614	0.001	0.001	0.001	0.0004	0.0003	0.0000	0.0000
TC A[c]	10-20	0.007	0.003	0.053	1.582	0.001	0.002	0.005	0.0009	0.0005	0.0001	0.0002
TC A	35-45	0.007	0.003	0.070	1.456	0.001	0.002	0.005	0.0008	0.0005	0.0001	0.0008
TC A	80-90	0.002	0.012	0.017	0.504	0.000	0.001	0.001	0.0003	0.0001	BDL	0.0000
TC A	123-133	0.008	0.003	0.082	1.820	0.001	0.003	0.007	0.0010	0.0006	0.0001	0.0004
TC A	165-175	0.002	0.009	0.017	0.500	0.000	0.001	0.001	0.0002	0.0001	BDL	BDL
TC A	187.5-197.5	0.003	0.005	0.021	0.669	0.000	0.001	0.001	0.0004	0.0002	0.0001	0.0001
TC B[c]	7.5-17.5	0.002	0.003	0.022	0.654	0.000	0.001	0.001	0.0003	0.0001	0.0001	0.0001
TC B	33-43	BDL	BDL	0.020	0.428	BDL	0.001	0.001	0.0003	0.0001	0.0000	0.0001
TC B	50-58	0.009	0.002	0.082	1.791	0.001	0.003	0.007	0.0010	0.0005	0.0001	0.0007
MC	0-8	BDL	BDL	0.012	0.339	0.000	0.000	0.001	0.0003	BDL	BDL	0.0001

Table S3A (continued): Elemental abundances (%) in sediment samples.

sample description		*element*										
location[a]	depth (cm)	V	Cr	Mn	Fe	Ni	Cu	Zn	Ga	As	Se	Br
SJ	0-5	0.004	0.004	0.040	1.454	0.001	0.002	0.005	0.0009	0.0003	BDL	0.0001
SJ	0-6	0.004	BDL	0.034	1.094	0.001	0.001	0.004	0.0008	0.0001	BDL	0.0002
SJ	0-8	0.002	0.005	0.027	0.767	0.000	0.001	0.002	0.0005	0.0002	BDL	0.0001
SJ	10-15	0.004	0.007	0.033	1.135	0.000	0.001	0.003	0.0007	0.0003	BDL	0.0001
SJ	20-25	BDL	BDL	0.027	0.761	0.000	0.001	0.002	0.0005	0.0002	BDL	BDL
SJ	30-35	BDL	0.007	0.024	0.754	0.000	0.001	0.002	0.0006	0.0001	BDL	0.0000
NC A	0-12	BDL	BDL	0.012	0.199	BDL	0.000	0.001	0.0003	BDL	0.0001	BDL
NC B	0-8	BDL	BDL	0.019	0.510	0.000	0.001	0.001	0.0004	0.0001	BDL	0.0001
NC B	0-12	BDL	BDL	0.028	0.718	0.001	0.001	0.002	0.0005	0.0003	0.0000	0.0001
median crustal abundance[b]		0.0012	0.0010	0.0950	5.6300	0.0084	0.0060	0.0070	0.0019	0.0002	$5 \cdot 10^{-6}$	0.0002

sample description		*element*								
location[a]	depth (cm)	Rb	Sr	Y	Zr	Ba	La	Ce	Pb	Th	U
Lakebed Samples, March 2006											
245.0	0-5	0.0104	0.0252	0.0024	BDL	0.0445	0.0037	0.0086	0.0024	0.0014	0.0007
245.0	0-16	0.0107	0.0260	0.0024	BDL	0.0425	0.0045	0.0080	0.0025	0.0014	0.0004
245.0	15-30	0.0100	0.0256	0.0024	BDL	0.0473	0.0066	0.0084	0.0023	0.0011	0.0004
245.0	60-75	0.0105	0.0246	0.0025	BDL	0.0405	0.0049	0.0075	0.0022	0.0013	0.0004
241.0	0-5	0.0108	0.0241	0.0025	BDL	0.0447	0.0067	0.0115	0.0024	0.0014	0.0005
241.0	0-12.5	0.0112	0.0256	0.0027	BDL	0.0424	0.0036	0.0076	0.0028	0.0013	0.0006
238.5	0-15	0.0122	0.0244	0.0025	BDL	0.0438	0.0055	0.0139	0.0027	0.0016	0.0006
238.5	0-12.5	0.0119	0.0243	0.0024	BDL	0.0420	0.0057	0.0095	0.0027	0.0014	0.0005
238.5	25-40	0.0091	0.0268	0.0026	BDL	0.0534	0.0061	0.0131	0.0026	0.0013	0.0005
238.5	40-50	0.0089	0.0268	0.0025	BDL	0.0522	0.0071	0.0131	0.0025	0.0014	0.0007
235.5	0-15	0.0120	0.0239	0.0027	BDL	0.0415	0.0067	0.0113	0.0029	0.0015	0.0009
235.5	0-15	0.0114	0.0239	0.0025	BDL	0.0456	0.0052	0.0100	0.0026	0.0014	0.0006
235.5	25-40	0.0113	0.0254	0.0025	BDL	0.0485	0.0063	0.0115	0.0028	0.0015	0.0006
168.0	5-15	0.0118	0.0225	0.0026	BDL	0.0326	0.0053	0.0106	0.0023	0.0016	0.0006

Table S3A (continued): Elemental abundances (%) in sediment samples.

sample description		*element*									
location[a]	depth (cm)	Rb	Sr	Y	Zr	Ba	La	Ce	Pb	Th	U
Lakebed Samples, May 2006											
241.0	5-15	0.0072	0.0217	0.0019	BDL	0.0593	0.0067	0.0105	0.0020	0.0008	0.0003
238.5	0-5	0.0106	0.0253	0.0023	BDL	0.0437	BDL	0.0069	0.0025	0.0015	0.0004
193.0	0-15	0.0113	0.0241	0.0023	BDL	0.0448	0.0057	0.0103	0.0027	0.0015	0.0006
Delta Shoreline Samples											
249.5	-132 to -122	0.0087	0.0233	0.0024	BDL	0.0510	0.0067	0.0097	0.0019	0.0012	0.0005
249.5	-102 to -94	0.0044	0.0152	0.0016	0.0507	0.0546	0.0064	0.0095	0.0015	0.0005	BDL
249.5	-94 to -87	0.0048	0.0165	0.0015	0.0528	0.0561	0.0046	0.0064	0.0019	0.0004	0.0003
249.5	-77 to -67	0.0047	0.0160	0.0014	0.0505	0.0505	0.0056	0.0099	0.0017	0.0003	0.0003
249.5	-57 to -47	0.0045	0.0166	0.0011	0.0536	0.0545	0.0044	0.0097	0.0016	0.0004	BDL
249.5	-47 to -37	0.0108	0.0257	0.0025	BDL	0.0520	0.0078	0.0123	0.0027	0.0013	0.0006
249.5	-12 to -2	0.0103	0.0244	0.0025	BDL	0.0450	0.0054	0.0115	0.0026	0.0013	0.0007
249.5	14 to 20	0.0098	0.0241	0.0022	BDL	0.0459	0.0037	0.0086	0.0027	0.0012	0.0004
247.5 A	0-8	0.0049	0.0159	0.0017	0.0577	0.0525	0.0040	0.0096	0.0013	0.0005	BDL
247.5 B	0-8	0.0054	0.0177	0.0017	0.0536	0.0526	0.0045	0.0080	0.0013	0.0005	BDL
247.5 B	0-10	0.0054	0.0176	0.0020	0.0577	0.0559	0.0053	0.0072	0.0014	0.0004	0.0003
247.5 C	0-8	0.0084	0.0240	0.0023	BDL	0.0502	0.0047	0.0095	0.0034	0.0011	0.0003
247.5 C	0-16	0.0081	0.0233	0.0022	0.0479	0.0546	0.0050	0.0092	0.0023	0.0010	0.0003
247.5 C	14-24	0.0071	0.0222	0.0017	BDL	0.0600	0.0047	0.0083	0.0027	0.0007	0.0005

Table S3A (continued): Elemental abundances (%) in sediment samples.

sample description		*element*									
location[a]	depth (cm)	Rb	Sr	Y	Zr	Ba	La	Ce	Pb	Th	U
Side Canyon Samples											
DD[c]	0-10	0.0055	0.0162	0.0012	BDL	0.0525	0.0065	0.0099	0.0009	0.0004	0.0002
DD	20-30	0.0061	0.0196	0.0015	BDL	0.0478	0.0047	0.0062	0.0013	0.0005	0.0004
DD	47-57	0.0039	0.0101	0.0006	BDL	0.0393	0.0031	0.0069	0.0006	0.0004	0.0002
DD	57-67	0.0061	0.0188	0.0016	0.0493	0.0548	0.0077	0.0136	0.0013	0.0006	0.0004
DD	77-87	0.0074	0.0263	0.0021	BDL	0.0420	0.0050	0.0074	0.0017	0.0010	0.0004
DD	102-122	0.0068	0.0216	0.0015	0.0461	0.0459	0.0040	0.0063	0.0013	0.0006	0.0004
DD	180-190	0.0096	0.0267	0.0022	BDL	0.0347	0.0054	0.0142	0.0020	0.0012	0.0005
FC A	0-12	0.0065	0.0091	0.0019	0.0641	0.0392	0.0024	0.0068	0.0013	0.0006	0.0004
FC A	12-17	0.0059	0.0078	0.0017	0.0666	0.0449	0.0057	0.0120	0.0012	0.0006	0.0002
FC A	42.5-52.5	0.0069	0.0095	0.0017	0.0714	0.0425	0.0102	0.0135	0.0014	0.0007	BDL
FC A	57.5-67.5	0.0058	0.0072	0.0016	0.0542	0.0453	0.0090	0.0137	0.0013	0.0006	BDL
FC B	0-4	0.0061	0.0078	0.0022	0.0653	0.0410	0.0051	0.0112	0.0011	0.0006	BDL
FC B	0-8	0.0049	0.0067	0.0025	0.0683	0.0412	0.0035	0.0073	0.0012	0.0005	BDL
FC B	0-8	0.0048	0.0066	0.0022	0.0722	0.0435	0.0061	0.0101	0.0011	0.0005	0.0002
FC B	16-24	0.0046	0.0066	0.0018	BDL	0.0400	0.0071	0.0141	0.0013	0.0005	BDL
FC B	16-24	0.0048	0.0069	0.0018	0.0629	0.0383	0.0044	0.0077	0.0011	0.0006	BDL
WC A	0-10	0.0057	0.0118	0.0018	0.0515	0.0537	0.0106	0.0147	0.0032	0.0005	0.0003
WC A	0-12	0.0050	0.0093	0.0026	0.0672	0.0407	0.0038	BDL	0.0012	0.0004	BDL
WC A	0-14	0.0046	0.0086	0.0023	0.0698	0.0358	0.0040	0.0070	0.0010	0.0005	BDL
WC B	0-8	0.0047	0.0092	0.0019	0.0658	0.0413	0.0035	0.0071	0.0012	0.0005	BDL
WC B	0-8	0.0053	0.0101	0.0023	0.0694	0.0426	0.0061	0.0079	0.0012	0.0006	0.0003

Table S3A (continued): Elemental abundances (%) in sediment samples.

sample description		*element*									
location[a]	depth (cm)	Rb	Sr	Y	Zr	Ba	La	Ce	Pb	Th	U
WC C	0-8	0.0091	0.0207	0.0021	BDL	0.0402	0.0045	0.0086	0.0024	0.0011	0.0006
WC C	0-10	0.0089	0.0186	0.0024	BDL	0.0383	0.0035	0.0094	0.0022	0.0010	0.0006
WC C	4-6	0.0106	0.0203	0.0021	BDL	0.0402	0.0070	0.0082	0.0026	0.0012	0.0006
WC C	10-12	0.0109	0.0221	0.0021	BDL	0.0443	0.0050	0.0126	0.0028	0.0012	0.0005
WC C	20-22	0.0034	0.0064	0.0007	0.0467	0.0315	0.0068	0.0064	0.0008	0.0002	BDL
WC D	0-10	0.0037	0.0075	0.0024	0.0861	0.0357	0.0075	0.0111	0.0012	0.0006	BDL
WC D	0-11	0.0035	0.0074	0.0025	0.0580	0.0325	BDL	0.0061	0.0008	0.0005	BDL
WC D	30-44	0.0021	0.0068	0.0018	0.0638	0.0366	0.0074	0.0113	0.0008	0.0002	BDL
WC E	0-4	0.0034	0.0063	0.0012	0.0493	0.0344	0.0059	0.0086	0.0006	0.0003	BDL
WC E	0-8	0.0030	0.0059	0.0009	0.0505	0.0297	0.0032	0.0068	0.0007	0.0002	BDL
WC E	0-8	0.0032	0.0063	0.0010	0.0528	0.0291	0.0036	0.0059	0.0009	0.0003	BDL
WC E	16-24	0.0041	0.0074	0.0018	0.0687	0.0402	0.0058	0.0078	0.0011	0.0003	BDL
WC E	16-24	0.0042	0.0071	0.0015	0.0493	0.0381	0.0066	0.0097	0.0009	0.0005	BDL
TC A[c]	10-20	0.0075	0.0229	0.0018	BDL	0.0597	0.0049	0.0092	0.0023	0.0009	0.0005
TC A	35-45	0.0060	0.0230	0.0022	BDL	0.0512	0.0051	0.0093	0.0022	0.0007	0.0005
TC A	80-90	0.0042	0.0106	0.0007	BDL	0.0381	0.0042	0.0083	0.0010	0.0001	0.0002
TC A	123-133	0.0074	0.0228	0.0021	BDL	0.0578	0.0029	0.0099	0.0026	0.0010	0.0006
TC A	165-175	0.0044	0.0095	0.0006	0.0454	0.0413	0.0042	0.0059	0.0010	0.0003	BDL
TC A	187.5-197.5	0.0040	0.0135	0.0006	BDL	0.0443	0.0054	0.0078	0.0009	0.0003	0.0003
TC B[c]	7.5-17.5	0.0051	0.0116	0.0008	BDL	0.0447	0.0050	0.0081	0.0011	0.0003	0.0003
TC B	33-43	0.0030	0.0112	0.0012	0.0547	0.0385	0.0048	0.0061	0.0007	0.0002	BDL
TC B	50-58	0.0067	0.0268	0.0023	BDL	0.0565	0.0074	0.0101	0.0028	0.0010	0.0007
MC	0-8	0.0051	0.0058	0.0007	BDL	0.0388	0.0047	0.0065	0.0011	0.0003	BDL

Table S3A (continued): Elemental abundances (%) in sediment samples.

sample description		*element*									
location[a]	depth (cm)	Rb	Sr	Y	Zr	Ba	La	Ce	Pb	Th	U
SJ	0-5	0.0068	0.0186	0.0018	0.0458	0.0572	0.0064	0.0112	0.0020	0.0008	0.0002
SJ	0-6	0.0063	0.0160	0.0018	0.0582	0.0587	0.0050	0.0072	0.0019	0.0007	BDL
SJ	0-8	0.0058	0.0138	0.0016	0.0662	0.0631	0.0068	0.0114	0.0012	0.0006	0.0002
SJ	10-15	0.0067	0.0178	0.0018	0.0600	0.0598	0.0042	0.0109	0.0014	0.0008	0.0002
SJ	20-25	0.0059	0.0134	0.0013	0.0471	0.0557	0.0053	0.0093	0.0013	0.0005	BDL
SJ	30-35	0.0057	0.0127	0.0016	0.0731	0.0658	0.0072	0.0120	0.0013	0.0006	BDL
NC A	0-12	0.0043	0.0038	0.0021	0.0660	0.0333	0.0044	0.0087	0.0008	0.0001	BDL
NC B	0-8	0.0057	0.0060	0.0012	0.0546	0.0421	0.0047	0.0061	0.0012	0.0004	BDL
NC B	0-12	0.0062	0.0072	0.0018	0.0539	0.0448	0.0052	0.0069	0.0011	0.0004	BDL
median crustal abundance[b]		0.0090	0.0370	0.0033	0.0165	$1{\cdot}10^{-7}$	0.0003	0.0425	0.0014	0.0010	0.0003

[a] "Location" refers to distance from Glen Canyon Dam (in river km) for delta samples and to side canyon location.

[b] Median crustal abundance data from Lide (2007).

[c] For DD and TC side canyon samples only, depth refers to depth below the tops of sets of cores collected above the water line.

Table S3B: Elemental abundances (molar ratios, normalized to silicon) in sediment samples.

sample description							*element*					
location[a]	depth (cm)	org C	tot C	Mg	Al	Si	P	S	Cl	K	Ca	Ti
Lakebed Samples, March 2006												
245.0	0-5	0.11	0.28	0.092	0.298	1	0.0023	0.0017	2.8E-04	0.063	0.184	0.0096
245.0	0-16	0.12	0.28	0.093	0.306	1	0.0024	0.0021	6.2E-04	0.065	0.187	0.0097
245.0	15-30	0.13	0.28	0.091	0.306	1	0.0025	0.0021	5.5E-04	0.062	0.178	0.0090
245.0	60-75	0.10	0.29	0.091	0.299	1	0.0024	0.0018	4.3E-04	0.064	0.182	0.0093
241.0	0-5	0.10	0.26	0.085	0.326	1	0.0023	0.0018	5.3E-04	0.063	0.156	0.0094
241.0	0-12.5	0.09	0.26	0.088	0.321	1	0.0024	0.0017	6.9E-04	0.064	0.162	0.0094
238.5	0-12.5	0.09		0.083	0.335	1	0.0023	0.0016	2.4E-04	0.069	0.140	0.0093
238.5	0-15			0.083	0.332	1	0.0023	0.0016	3.0E-04	0.070	0.146	0.0095
238.5	25-40	0.11	0.29	0.086	0.281	1	0.0026	0.0025	2.9E-04	0.056	0.189	0.0085
238.5	40-50	0.10	0.29	0.084	0.265	1	0.0027	0.0025	3.3E-04	0.056	0.191	0.0086
235.5	0-15	0.08	0.20	0.081	0.319	1	0.0022	0.0013	3.2E-04	0.067	0.142	0.0096
235.5	0-15	0.10	0.25	0.081	0.320	1	0.0022	0.0014	3.2E-04	0.066	0.148	0.0096
235.5	25-40	0.09	0.24	0.081	0.313	1	0.0025	0.0019	3.6E-04	0.062	0.153	0.0091
168.0	5-15	0.10	0.25	0.077	0.332	1	0.0027	0.0028	3.4E-04	0.058	0.152	0.0088
Lakebed Samples, May 2006												
241.0	5-15	0.12		0.066	0.201	1	0.0023	0.0025	2.5E-04	0.050	0.161	0.0067
238.5	0-5	0.13	0.29	0.084	0.301	1	0.0025	0.0027	4.7E-04	0.062	0.172	0.0095
193.0	0-15	0.09	0.88	0.080	0.314	1	0.0023	0.0013	2.8E-04	0.064	0.149	0.0093
Delta Shoreline Samples												
249.5	-132 to -122		0.23	0.077	0.256	1	0.0022	0.0018	2.9E-04	0.057	0.167	0.0082
249.5	-102 to -94	0.00	0.09	0.023	0.082	1	0.0007	0.0002	1.6E-04	0.031	0.068	0.0020
249.5	-94 to -87	0.00	0.10	0.030	0.101	1	0.0010	0.0005	1.6E-04	0.035	0.088	0.0026
249.5	-77 to -67	0.00	0.05	0.030	0.098	1	0.0009	0.0009	2.2E-04	0.033	0.082	0.0024
249.5	-57 to -47	0.01	0.05	0.026	0.097	1	0.0008	0.0004	2.1E-04	0.034	0.088	0.0023
249.5	-47 to -37	0.10	0.28	0.077	0.292	1	0.0024	0.0020	2.6E-04	0.062	0.165	0.0093
249.5	-12 to -2	0.11	0.28	0.077	0.294	1	0.0024	0.0018	3.0E-04	0.063	0.173	0.0092
249.5	14 to 20			0.076	0.296	1	0.0024	0.0018	2.1E-04	0.061	0.160	0.0086

Table S3B (continued): Elemental abundances (molar ratios, normalized to silicon) in sediment samples.

sample description				*element*								
location[a]	depth (cm)	org C	tot C	Mg	Al	Si	P	S	Cl	K	Ca	Ti
247.5 A	0-8	0.00	0.07	0.027	0.089	1	0.0009	0.0003	4.5E-04	0.033	0.075	0.0027
247.5 B	0-8	0.01	0.09	0.033	0.110	1	0.0011	0.0004	3.8E-04	0.038	0.087	0.0030
247.5 B	0-10	0.01	0.07	0.031	0.104	1	0.0010	0.0002	1.6E-04	0.036	0.080	0.0026
247.5 C	0-8	0.35	0.43	0.073	0.246	1	0.0025	0.0064	4.9E-04	0.055	0.164	0.0074
247.5 C	0-16	0.48	0.51	0.067	0.224	1	0.0028	0.0049	3.3E-04	0.053	0.154	0.0068
247.5 C	14-24	0.11	0.23	0.058	0.189	1	0.0020	0.0032	3.2E-04	0.051	0.144	0.0055
Side Canyon Samples												
DD[c]	0-10		0.15	0.049	0.114	1	0.0015	0.0022	6.8E-04	0.042	0.155	0.0046
DD	20-30		0.22	0.057	0.150	1	0.0018	0.0039	4.8E-04	0.047	0.188	0.0054
DD	47-57		0.42	0.034	0.075	1	0.0007	0.0012	5.3E-04	0.037	0.117	0.0032
DD	57-67		0.20	0.063	0.148	1	0.0022	0.0031	2.2E-03	0.047	0.195	0.0056
DD	77-87	0.09		0.081	0.219	1	0.0022	0.0031	6.0E-04	0.058	0.249	0.0081
DD	102-122	0.02	0.20	0.073	0.208	1	0.0020	0.0030	5.2E-04	0.053	0.181	0.0061
DD	130-140		0.19									
DD	167.5-177.5		0.34									
DD	180-190	0.10	0.31	0.080	0.262	1	0.0023	0.0026	2.6E-04	0.058	0.212	0.0089
DD	195-205		0.36									
FC A	0-12	0.02	0.14	0.065	0.214	1	0.0010	0.0076	7.0E-04	0.067	0.108	0.0075
FC A	12-17			0.048	0.181	1	0.0009	0.0007	2.9E-04	0.060	0.085	0.0066
FC A	17.5-27.5	0.01	0.10									
FC A	42.5-52.5	0.02	0.13	0.069	0.272	1	0.0014	0.0015	4.5E-04	0.075	0.111	0.0081
FC A	57.5-67.5	0.01	0.08	0.045	0.142	1	0.0004	0.0004	3.7E-04	0.055	0.069	0.0047

Table S3B (continued): Elemental abundances (molar ratios, normalized to silicon) in sediment samples.

sample description				*element*								
location[a]	depth (cm)	org C	tot C	Mg	Al	Si	P	S	Cl	K	Ca	Ti
FC B	0-4	0.02	0.12	0.054	0.155	1	0.0007	0.0007	3.6E-04	0.056	0.083	0.0058
FC B	0-8	0.01	0.10	0.047	0.111	1	0.0006	BDL	1.9E-04	0.045	0.090	0.0042
FC B	0-8	0.00	0.09	0.045	0.106	1	0.0007	0.0002	2.3E-04	0.045	0.087	0.0042
FC B	4-8	0.00	0.09									
FC B	8-12	0.01	0.10									
FC B	8-16	0.00	0.11									
FC B	8-16	0.00	0.10									
FC B	12-16	0.01	0.11									
FC B	16-20	BDL	0.09									
FC B	16-24	0.00	0.10	0.046	0.103	1	0.0004	BDL	3.4E-04	0.043	0.095	0.0038
FC B	16-24	0.00	0.12	0.048	0.113	1	0.0005	BDL	4.7E-04	0.045	0.102	0.0041
FC B	20-24	0.01	0.13									
FC B	24-28	0.00	0.11									
FC B	24-32	0.00	0.13									
FC B	24-32	0.00	0.18									
FC B	28-32	0.00	0.11									
FC B	32-36	0.00	0.10									
WC A	0-10		0.30									
WC A	0-10			0.066	0.153	1	0.0008	0.0011	3.1E-04	0.052	0.137	0.0049
WC A	0-12	0.02	0.20	0.057	0.112	1	0.0010	0.0001	1.8E-04	0.044	0.110	0.0040
WC A	0-14	0.03	0.16	0.051	0.095	1	0.0009	0.0004	2.2E-04	0.038	0.108	0.0035
WC B	0-8	0.01	0.13	0.054	0.102	1	0.0007	0.0002	1.5E-04	0.040	0.105	0.0038
WC B	0-8	0.01	0.14	0.058	0.119	1	0.0008	0.0001	1.5E-04	0.044	0.112	0.0047
WC C	0-8	0.06	0.22	0.089	0.363	1	0.0016	0.0044	1.1E-03	0.084	0.165	0.0101
WC C	0-10	0.05	0.26	0.083	0.344	1	0.0015	0.0020	7.6E-04	0.082	0.151	0.0102
WC C	4-6			0.089	0.394	1	0.0014	0.0034	3.9E-04	0.100	0.152	0.0117
WC C	10-12			0.085	0.379	1	0.0017	0.0051	4.9E-04	0.093	0.161	0.0113
WC C	20-22			0.044	0.109	1	0.0006	0.0035	7.0E-04	0.040	0.122	0.0037

Table S3B (continued): Elemental abundances (molar ratios, normalized to silicon) in sediment samples.

sample description				*element*								
location[a]	depth (cm)	org C	tot C	Mg	Al	Si	P	S	Cl	K	Ca	Ti
WC D	0-10	0.01	0.08									
WC D	0-10	0.01	0.12	0.049	0.092	1	0.0009	0.0002	2.6E-04	0.032	0.098	0.0037
WC D	0-11	0.01	0.14	0.047	0.082	1	0.0002	0.0000	1.3E-04	0.030	0.094	0.0032
WC D	30-44	0.00	0.08	0.034	0.035	1	0.0004	0.0002	1.9E-04	0.019	0.099	0.0018
WC E	0-4	BDL	0.09	0.042	0.060	1	BDL	0.0001	4.2E-04	0.029	0.081	0.0022
WC E	0-8			0.039	0.049	1	BDL	0.0001	2.2E-04	0.025	0.077	0.0020
WC E	0-8	0.00	0.08	0.042	0.058	1	0.0000	0.0001	1.9E-04	0.027	0.082	0.0023
WC E	4-8	0.00	0.07									
WC E	8-12	0.00	0.07									
WC E	8-16	0.01	0.10									
WC E	12-16	0.00	0.07									
WC E	16-20	0.00	0.09									
WC E	16-24			0.046	0.081	1	0.0004	0.0001	2.8E-04	0.035	0.087	0.0031
WC E	16-24	0.01	0.11	0.046	0.077	1	0.0003	0.0001	2.7E-04	0.035	0.086	0.0025
WC E	20-24	0.00	0.08									
WC E	24-28	0.00	0.09									
WC E	28-32	0.01	0.11									
TC A[c]	10-20	0.44	0.58	0.045	0.210	1	0.0030	0.0019	2.7E-04	0.052	0.114	0.0064
TC A	35-45	1.76	2.32	0.063	0.232	1	0.0051	0.0065	3.2E-04	0.056	0.204	0.0072
TC A	80-90	0.00	0.09	0.028	0.077	1	0.0004	BDL	1.7E-04	0.032	0.072	0.0023
TC A	123-133	0.74	1.73	0.055	0.222	1	0.0040	0.0047	2.6E-04	0.054	0.145	0.0075
TC A	165-175	0.00	0.08	0.033	0.088	1	0.0004	0.0001	2.3E-04	0.037	0.085	0.0023
TC A	187.5-197.5	0.07	0.15	0.039	0.120	1	0.0012	0.0032	3.3E-04	0.040	0.106	0.0028
TC A	205-215		0.08									
TC B[c]	7.5-17.5	0.03	0.10	0.040	0.125	1	0.0013	0.0007	2.0E-04	0.044	0.114	0.0035
TC B	33-43		0.05	0.019	0.052	1	0.0003	BDL	1.2E-04	0.023	0.050	0.0016
TC B	50-58		0.75	0.052	0.253	1	0.0049	0.0060	4.1E-04	0.054	0.149	0.0076
MC	0-8	0.04	0.02	0.022	0.061	1	BDL	0.0008	1.8E-04	0.036	0.022	0.0017

Table S3B (continued): Elemental abundances (molar ratios, normalized to silicon) in sediment samples.

sample description				*element*								
location[a]	depth (cm)	org C	tot C	Mg	Al	Si	P	S	Cl	K	Ca	Ti
SJ	0-5			0.039	0.173	1	0.0007	0.0008	1.0E-04	0.042	0.082	0.0055
SJ	0-6	0.02		0.030	0.135	1	0.0005	0.0007	1.7E-04	0.039	0.067	0.0043
SJ	0-8	0.00	0.04	0.025	0.100	1	0.0002	0.0012	6.9E-04	0.037	0.056	0.0037
SJ	10-15			0.036	0.147	1	0.0006	0.0004	1.5E-04	0.043	0.079	0.0047
SJ	20-25			0.026	0.116	1	0.0002	0.0003	8.1E-05	0.040	0.063	0.0036
SJ	30-35			0.024	0.102	1	0.0004	0.0001	8.8E-05	0.037	0.053	0.0034
NC A	0-12	BDL	0.01	0.014	0.037	1	0.0003	BDL	2.0E-04	0.029	0.018	0.0014
NC B	0-8	0.01	0.04	0.029	0.084	1	0.0001	0.0004	2.1E-04	0.039	0.042	0.0026
NC B	0-12	0.02	0.07	0.044	0.120	1	0.0009	0.0020	1.2E-04	0.046	0.060	0.0032
median crustal abundance[b]				0.095	0.304	1	0.0034	0.0011	4.1E-04	0.053	0.103	0.0118

sample description				*element*								
location[a]	depth (cm)	V	Cr	Mn	Fe	Ni	Cu	Zn	Ga	As	Se	Br
Lakebed Samples, March 2006												
245.0	0-5	4.2E-04	1.6E-04	0.0013	0.068	4.5E-05	5.5E-05	1.7E-04	3.0E-05	1.6E-05	BDL	6.5E-06
245.0	0-16	3.5E-04	1.8E-04	0.0014	0.069	4.7E-05	5.5E-05	1.8E-04	2.8E-05	1.7E-05	1.4E-06	8.2E-06
245.0	15-30	2.7E-04	1.4E-04	0.0012	0.059	4.4E-05	4.2E-05	1.5E-04	2.5E-05	1.5E-05	1.7E-06	7.0E-06
245.0	60-75	3.4E-04	1.6E-04	0.0012	0.064	4.3E-05	5.1E-05	1.6E-04	2.8E-05	1.7E-05	1.6E-06	5.1E-06
241.0	0-5	3.8E-04	1.6E-04	0.0011	0.070	5.1E-05	5.4E-05	1.8E-04	3.4E-05	1.7E-05	1.0E-06	7.7E-06
241.0	0-12.5	3.4E-04	2.0E-04	0.0012	0.067	4.1E-05	5.7E-05	1.8E-04	3.1E-05	1.5E-05	2.2E-06	7.7E-06
238.5	0-12.5	4.2E-04	1.4E-04	0.0011	0.071	4.4E-05	5.8E-05	1.8E-04	3.4E-05	1.7E-05	8.9E-07	4.7E-06
238.5	0-15	4.1E-04	1.5E-04	0.0011	0.073	5.0E-05	5.3E-05	1.8E-04	3.4E-05	1.6E-05	9.4E-07	4.9E-06
238.5	25-40	3.4E-04	1.3E-04	0.0013	0.055	3.9E-05	4.3E-05	1.6E-04	2.3E-05	1.3E-05	1.7E-06	4.8E-06
238.5	40-50	2.9E-04	7.8E-05	0.0013	0.052	3.9E-05	3.7E-05	1.4E-04	2.0E-05	1.3E-05	1.1E-06	4.6E-06
235.5	0-15	4.5E-04	1.3E-04	0.0010	0.064	4.3E-05	4.5E-05	1.7E-04	2.8E-05	1.2E-05	1.4E-06	4.2E-06
235.5	0-15	4.3E-04	1.5E-04	0.0012	0.072	4.9E-05	5.0E-05	1.9E-04	3.2E-05	1.6E-05	1.3E-06	4.7E-06
235.5	25-40	3.8E-04	1.6E-04	0.0012	0.063	4.6E-05	4.6E-05	1.8E-04	2.9E-05	1.4E-05	1.6E-06	5.6E-06
168.0	5-15	4.1E-04	1.5E-04	0.0008	0.058	4.9E-05	4.1E-05	1.7E-04	3.1E-05	1.1E-05	1.9E-06	4.6E-06

Table S3B (continued): Elemental abundances (molar ratios, normalized to silicon) in sediment samples.

sample description		*element*										
location[a]	depth (cm)	V	Cr	Mn	Fe	Ni	Cu	Zn	Ga	As	Se	Br
Lakebed Samples, May 2006												
241.0	5-15	1.3E-04	6.7E-05	0.0009	0.036	3.3E-05	3.3E-05	9.8E-05	1.6E-05	8.0E-06	BDL	3.8E-06
238.5	0-5	3.9E-04	1.6E-04	0.0013	0.067	5.0E-05	5.7E-05	1.8E-04	3.0E-05	1.4E-05	9.3E-07	7.5E-06
193.0	0-15	4.1E-04	1.3E-04	0.0012	0.071	5.1E-05	5.1E-05	1.9E-04	2.9E-05	1.7E-05	9.4E-07	4.9E-06
Delta Shoreline Samples												
249.5	-132 to -122	2.4E-04	1.3E-04	0.0010	0.046	3.3E-05	3.9E-05	1.2E-04	2.1E-05	1.1E-05	1.1E-06	2.7E-06
249.5	-102 to -94	3.9E-05	BDL	0.0003	0.011	5.0E-06	8.0E-06	2.7E-05	7.4E-06	2.8E-06	BDL	9.2E-07
249.5	-94 to -87	7.3E-05	BDL	0.0004	0.015	6.1E-06	6.4E-06	4.0E-05	6.4E-06	3.4E-06	BDL	5.5E-07
249.5	-77 to -67	4.6E-05	2.3E-04	0.0004	0.015	6.0E-06	1.1E-05	3.5E-05	6.7E-06	5.8E-06	5.6E-07	1.3E-06
249.5	-57 to -47	5.6E-05	BDL	0.0004	0.013	BDL	8.5E-06	3.4E-05	7.3E-06	5.2E-06	BDL	5.6E-07
249.5	-47 to -37	4.0E-04	1.4E-04	0.0013	0.067	5.0E-05	4.6E-05	1.9E-04	3.0E-05	1.3E-05	1.9E-06	3.6E-06
249.5	-12 to -2	3.9E-04	1.7E-04	0.0012	0.067	4.7E-05	5.3E-05	1.9E-04	2.8E-05	1.3E-05	1.3E-06	4.3E-06
249.5	14 to 20	3.5E-04	1.2E-04	0.0011	0.060	4.2E-05	5.2E-05	1.6E-04	2.7E-05	1.3E-05	2.1E-06	3.8E-06
247.5 A	0-8	BDL	BDL	0.0004	0.012	6.6E-06	7.8E-06	3.0E-05	6.9E-06	3.2E-06	BDL	7.2E-07
247.5 B	0-8	3.0E-05	BDL	0.0004	0.013	7.1E-06	1.1E-05	3.5E-05	9.5E-06	4.0E-06	BDL	7.6E-07
247.5 B	0-10	6.3E-05	BDL	0.0004	0.013	1.1E-05	8.6E-06	3.0E-05	7.5E-06	2.9E-06	BDL	1.2E-06
247.5 C	0-8	3.1E-04	1.2E-04	0.0010	0.048	4.7E-05	3.3E-04	2.4E-04	2.1E-05	1.7E-05	1.9E-06	6.4E-06
247.5 C	0-16	2.5E-04	BDL	0.0010	0.042	3.3E-05	4.4E-05	1.3E-04	1.8E-05	1.1E-05	1.5E-06	7.4E-06
247.5 C	14-24	1.5E-04	5.4E-05	0.0007	0.031	2.8E-05	4.0E-04	2.3E-04	1.3E-05	6.5E-06	1.3E-06	3.6E-06

Table S3B (continued): Elemental abundances (molar ratios, normalized to silicon) in sediment samples.

sample description		*element*										
location[a]	depth (cm)	V	Cr	Mn	Fe	Ni	Cu	Zn	Ga	As	Se	Br
Side Canyon Samples												
DD[c]	0-10	6.5E-05	4.9E-04	0.0006	0.021	8.8E-06	2.1E-05	3.1E-05	1.0E-05	4.8E-06	9.4E-07	1.2E-06
DD	20-30	1.1E-04	9.3E-05	0.0008	0.026	1.7E-05	2.7E-05	5.5E-05	1.1E-05	6.3E-06	BDL	2.2E-06
DD	47-57	7.9E-05	1.3E-03	0.0005	0.019	1.4E-05	1.7E-05	2.2E-05	5.3E-06	5.1E-06	BDL	1.8E-06
DD	57-67	8.8E-05	8.9E-04	0.0007	0.030	2.1E-05	2.2E-05	5.3E-05	1.4E-05	6.4E-06	6.4E-07	2.5E-06
DD	77-87	1.5E-04	1.4E-04	0.0011	0.044	3.2E-05	3.3E-05	9.7E-05	1.8E-05	9.7E-06	1.0E-06	1.3E-06
DD	102-122	2.1E-04	2.3E-04	0.0008	0.033	1.5E-05	2.5E-05	6.5E-05	1.4E-05	5.9E-06	BDL	2.0E-06
DD	180-190	3.0E-04	2.0E-04	0.0010	0.065	3.8E-05	4.0E-05	1.6E-04	2.5E-05	1.1E-05	2.1E-06	2.4E-06
FC A	0-12	8.4E-05	3.4E-04	0.0006	0.030	2.0E-05	1.8E-05	4.1E-05	1.3E-05	3.8E-06	9.0E-07	1.3E-06
FC A	12-17	BDL	3.6E-04	0.0005	0.025	1.5E-05	1.6E-05	3.2E-05	1.3E-05	5.3E-06	7.4E-07	1.0E-06
FC A	42.5-52.5	1.2E-04	9.2E-04	0.0007	0.040	3.2E-05	2.4E-05	5.4E-05	1.4E-05	6.5E-06	BDL	1.7E-06
FC A	57.5-67.5	BDL	6.0E-05	0.0004	0.016	1.3E-05	9.5E-06	2.7E-05	6.6E-06	4.0E-06	BDL	7.8E-07
FC B	0-4	4.6E-05	1.2E-04	0.0005	0.020	1.8E-05	1.1E-05	2.9E-05	1.1E-05	6.0E-06	BDL	9.0E-07
FC B	0-8	BDL	4.1E-05	0.0005	0.015	1.1E-05	8.7E-06	2.1E-05	6.2E-06	3.4E-06	BDL	6.6E-07
FC B	0-8	4.3E-05	3.6E-05	0.0005	0.014	1.1E-05	9.2E-06	2.0E-05	6.1E-06	3.7E-06	6.6E-07	7.5E-07
FC B	16-24	BDL	6.4E-05	0.0005	0.014	9.8E-06	1.2E-05	1.9E-05	6.1E-06	2.7E-06	BDL	5.5E-07
FC B	16-24	BDL	BDL	0.0005	0.014	8.7E-06	1.1E-05	2.1E-05	6.3E-06	4.6E-06	BDL	6.7E-07
WC A	0-10	9.2E-05	6.9E-05	0.0007	0.021	1.7E-05	2.1E-04	1.1E-04	7.7E-06	6.0E-06	BDL	2.1E-06
WC A	0-12	BDL	BDL	0.0005	0.013	9.2E-06	1.9E-05	2.1E-05	5.8E-06	2.0E-06	5.8E-07	6.9E-07
WC A	0-14	BDL	BDL	0.0005	0.012	7.7E-06	1.9E-05	2.2E-05	6.1E-06	1.8E-06	BDL	1.6E-06
WC B	0-8	BDL	BDL	0.0005	0.013	9.2E-06	1.8E-05	2.1E-05	5.1E-06	2.4E-06	BDL	1.5E-06
WC B	0-8	BDL	5.9E-05	0.0006	0.016	1.5E-05	1.9E-05	2.5E-05	9.2E-06	3.6E-06	BDL	1.3E-06

Table S3B (continued): Elemental abundances (molar ratios, normalized to silicon) in sediment samples.

sample description		*element*										
location[a]	depth (cm)	V	Cr	Mn	Fe	Ni	Cu	Zn	Ga	As	Se	Br
WC C	0-8	2.0E-04	1.3E-04	0.0011	0.062	5.1E-05	6.4E-05	1.1E-04	2.7E-05	1.6E-05	8.1E-07	4.7E-06
WC C	0-10	2.2E-04	2.0E-04	0.0011	0.059	4.6E-05	5.9E-05	8.6E-05	2.6E-05	1.1E-05	1.0E-06	3.5E-06
WC C	4-6	2.5E-04	2.0E-04	0.0014	0.084	5.8E-05	7.3E-05	1.3E-04	3.8E-05	1.7E-05	BDL	2.8E-06
WC C	10-12	3.9E-04	1.2E-04	0.0012	0.088	7.0E-05	8.8E-05	1.6E-04	3.5E-05	2.1E-05	1.8E-06	6.5E-06
WC C	20-22	BDL	5.5E-05	0.0005	0.015	9.4E-06	2.1E-05	1.7E-05	2.9E-06	9.7E-07	BDL	1.1E-06
WC D	0-10	4.0E-05	4.6E-05	0.0005	0.013	5.6E-06	9.7E-05	4.8E-05	4.4E-06	2.8E-06	4.5E-07	1.3E-06
WC D	0-11	BDL	BDL	0.0005	0.011	5.9E-06	1.6E-05	1.6E-05	3.7E-06	2.9E-06	BDL	1.1E-06
WC D	30-44	BDL	BDL	0.0004	0.008	2.8E-06	1.1E-04	4.2E-05	2.9E-06	2.9E-06	BDL	1.3E-06
WC E	0-4	BDL	BDL	0.0004	0.008	2.8E-06	1.4E-05	1.4E-05	4.3E-06	3.3E-06	5.2E-07	1.0E-06
WC E	0-8	BDL	BDL	0.0004	0.007	3.1E-06	1.1E-05	1.2E-05	2.7E-06	1.5E-06	BDL	6.2E-07
WC E	0-8	BDL	BDL	0.0004	0.008	5.7E-06	1.1E-05	1.3E-05	3.3E-06	2.4E-06	BDL	6.2E-07
WC E	16-24	BDL	BDL	0.0004	0.010	6.0E-06	1.5E-05	1.5E-05	4.6E-06	1.3E-06	4.4E-07	6.5E-07
WC E	16-24	BDL	BDL	0.0004	0.009	9.8E-06	1.1E-05	1.5E-05	4.6E-06	2.9E-06	4.4E-07	4.3E-07
TC A[c]	10-20	1.5E-04	6.7E-05	0.0011	0.032	2.0E-05	3.3E-05	9.0E-05	1.5E-05	7.7E-06	8.8E-07	2.8E-06
TC A	35-45	2.3E-04	1.1E-04	0.0021	0.043	2.5E-05	6.1E-05	1.2E-04	1.8E-05	1.1E-05	1.4E-06	1.7E-05
TC A	80-90	3.7E-05	2.4E-04	0.0003	0.010	5.6E-06	1.0E-05	1.4E-05	5.0E-06	7.1E-07	BDL	5.3E-07
TC A	123-133	2.1E-04	8.0E-05	0.0019	0.041	2.8E-05	5.5E-05	1.3E-04	1.7E-05	1.0E-05	1.3E-06	6.1E-06
TC A	165-175	3.7E-05	2.0E-04	0.0004	0.011	4.6E-06	1.1E-05	1.7E-05	3.2E-06	1.3E-06	BDL	BDL
TC A	187.5-197.5	9.1E-05	1.5E-04	0.0005	0.017	8.4E-06	1.7E-05	3.0E-05	7.2E-06	3.3E-06	9.1E-07	1.2E-06
TC B[c]	7.5-17.5	5.0E-05	7.7E-05	0.0005	0.015	8.7E-06	1.0E-05	2.5E-05	5.9E-06	2.4E-06	8.1E-07	1.4E-06
TC B	33-43	BDL	BDL	0.0003	0.006	BDL	6.4E-06	1.1E-05	3.2E-06	1.0E-06	3.9E-07	4.8E-07
TC B	50-58	2.5E-04	7.0E-05	0.0022	0.048	3.1E-05	7.1E-05	1.7E-04	2.2E-05	1.1E-05	1.7E-06	1.3E-05
MC	0-8	BDL	BDL	0.0002	0.005	2.2E-06	4.4E-06	8.3E-06	3.1E-06	BDL	BDL	9.5E-07

Table S3B (continued): Elemental abundances (molar ratios, normalized to silicon) in sediment samples.

sample description		*element*										
location[a]	depth (cm)	V	Cr	Mn	Fe	Ni	Cu	Zn	Ga	As	Se	Br
SJ	0-5	6.8E-05	6.3E-05	0.0007	0.024	1.3E-05	2.3E-05	6.5E-05	1.2E-05	3.4E-06	BDL	1.5E-06
SJ	0-6	6.8E-05	BDL	0.0005	0.017	9.8E-06	1.8E-05	4.8E-05	1.0E-05	1.1E-06	BDL	1.7E-06
SJ	0-8	3.4E-05	7.6E-05	0.0004	0.011	6.7E-06	1.1E-05	2.4E-05	5.5E-06	2.6E-06	BDL	8.2E-07
SJ	10-15	6.6E-05	1.2E-04	0.0005	0.018	5.6E-06	1.8E-05	3.5E-05	9.3E-06	3.4E-06	BDL	1.2E-06
SJ	20-25	BDL	BDL	0.0004	0.012	5.2E-06	1.1E-05	2.8E-05	6.0E-06	2.3E-06	BDL	BDL
SJ	30-35	BDL	1.2E-04	0.0004	0.011	5.6E-06	7.0E-06	2.4E-05	6.7E-06	1.4E-06	BDL	4.2E-07
NC A	0-12	BDL	BDL	0.0002	0.003	BDL	4.9E-06	5.8E-06	3.2E-06	BDL	4.7E-07	BDL
NC B	0-8	BDL	BDL	0.0003	0.007	4.5E-06	1.0E-05	1.7E-05	4.8E-06	8.3E-07	BDL	9.7E-07
NC B	0-12	BDL	BDL	0.0004	0.011	8.4E-06	1.4E-05	2.4E-05	6.8E-06	3.2E-06	4.0E-05	8.8E-07
median crustal abundance[b]		2.3E-05	2.0E-05	0.0017	0.100	1.4E-04	9.4E-05	1.1E-04	2.7E-05	2.4E-06	6.3E-08	3.0E-06

sample description		*element*								
location[a]	depth (cm)	Rb	Sr	Y	Zr	Ba	La	Ce	Pb	Th	U
Lakebed Samples, March 2006											
245.0	0-5	1.5E-04	3.7E-04	3.4E-05	BDL	4.1E-04	3.4E-05	7.8E-05	1.5E-05	7.4E-06	3.6E-06
245.0	0-16	1.6E-04	3.7E-04	3.3E-05	BDL	3.8E-04	4.0E-05	7.1E-05	1.5E-05	7.4E-06	2.1E-06
245.0	15-30	1.3E-04	3.3E-04	3.0E-05	BDL	3.9E-04	5.3E-05	6.7E-05	1.3E-05	5.5E-06	2.1E-06
245.0	60-75	1.5E-04	3.5E-04	3.5E-05	BDL	3.6E-04	4.4E-05	6.6E-05	1.3E-05	6.9E-06	1.8E-06
241.0	0-5	1.5E-04	3.4E-04	3.4E-05	BDL	4.0E-04	5.8E-05	1.0E-04	1.4E-05	7.2E-06	2.6E-06
241.0	0-12.5	1.5E-04	3.3E-04	3.4E-05	BDL	3.5E-04	3.0E-05	6.2E-05	1.5E-05	6.2E-06	2.8E-06
238.5	0-15	1.7E-04	3.3E-04	3.3E-05	BDL	3.8E-04	4.7E-05	1.2E-04	1.5E-05	8.1E-06	2.8E-06
238.5	0-12.5	1.7E-04	3.4E-04	3.3E-05	BDL	3.8E-04	5.1E-05	8.4E-05	1.6E-05	7.5E-06	2.8E-06
238.5	25-40	1.2E-04	3.4E-04	3.2E-05	BDL	4.4E-04	4.9E-05	1.0E-04	1.4E-05	6.3E-06	2.2E-06
238.5	40-50	1.2E-04	3.4E-04	3.1E-05	BDL	4.2E-04	5.7E-05	1.0E-04	1.3E-05	6.6E-06	3.2E-06
235.5	0-15	1.5E-04	2.9E-04	3.3E-05	BDL	3.2E-04	5.1E-05	8.6E-05	1.5E-05	7.0E-06	4.0E-06
235.5	0-15	1.7E-04	3.4E-04	3.4E-05	BDL	4.1E-04	4.7E-05	8.8E-05	1.6E-05	7.7E-06	3.2E-06
235.5	25-40	1.4E-04	3.2E-04	3.1E-05	BDL	3.9E-04	4.9E-05	9.0E-05	1.5E-05	6.9E-06	2.7E-06
168.0	5-15	1.6E-04	2.9E-04	3.2E-05	BDL	2.7E-04	4.3E-05	8.5E-05	1.2E-05	7.7E-06	2.9E-06

Table S3B (continued): Elemental abundances (molar ratios, normalized to silicon) in sediment samples.

sample description		*element*									
location[a]	depth (cm)	Rb	Sr	Y	Zr	Ba	La	Ce	Pb	Th	U
Lakebed Samples, May 2006											
241.0	5-15	9.8E-05	2.9E-04	2.5E-05	BDL	5.0E-04	5.6E-05	8.7E-05	1.1E-05	4.2E-06	1.6E-06
238.5	0-5	1.5E-04	3.5E-04	3.1E-05	BDL	3.9E-04	BDL	6.0E-05	1.5E-05	7.6E-06	2.0E-06
193.0	0-15	1.6E-04	3.4E-04	3.2E-05	BDL	4.0E-04	5.1E-05	9.1E-05	1.6E-05	7.8E-06	2.9E-06
Delta Shoreline Samples											
249.5	-132 to -122	1.1E-04	2.9E-04	3.0E-05	BDL	4.1E-04	5.3E-05	7.6E-05	1.0E-05	5.8E-06	2.5E-06
249.5	-102 to -94	4.2E-05	1.4E-04	1.4E-05	4.5E-04	3.2E-04	3.8E-05	5.5E-05	5.8E-06	1.6E-06	BDL
249.5	-94 to -87	4.9E-05	1.7E-04	1.5E-05	5.1E-04	3.6E-04	2.9E-05	4.0E-05	7.9E-06	1.6E-06	9.6E-07
249.5	-77 to -67	4.9E-05	1.6E-04	1.4E-05	4.9E-04	3.2E-04	3.5E-05	6.2E-05	7.1E-06	1.3E-06	1.0E-06
249.5	-57 to -47	4.8E-05	1.7E-04	1.1E-05	5.3E-04	3.6E-04	2.8E-05	6.2E-05	6.8E-06	1.5E-06	BDL
249.5	-47 to -37	1.6E-04	3.7E-04	3.4E-05	BDL	4.7E-04	7.0E-05	1.1E-04	1.6E-05	7.2E-06	3.2E-06
249.5	-12 to -2	1.6E-04	3.7E-04	3.7E-05	BDL	4.3E-04	5.1E-05	1.1E-04	1.6E-05	7.3E-06	3.9E-06
249.5	14 to 20	1.4E-04	3.3E-04	3.0E-05	BDL	4.0E-04	3.2E-05	7.4E-05	1.6E-05	6.1E-06	2.0E-06
247.5 A	0-8	4.7E-05	1.5E-04	1.5E-05	5.2E-04	3.2E-04	2.4E-05	5.6E-05	5.2E-06	1.8E-06	BDL
247.5 B	0-8	5.5E-05	1.8E-04	1.7E-05	5.1E-04	3.3E-04	2.8E-05	5.0E-05	5.5E-06	1.8E-06	BDL
247.5 B	0-10	5.3E-05	1.7E-04	1.9E-05	5.3E-04	3.4E-04	3.2E-05	4.3E-05	5.8E-06	1.6E-06	1.1E-06
247.5 C	0-8	1.1E-04	3.1E-04	3.0E-05	BDL	4.2E-04	3.9E-05	7.8E-05	1.9E-05	5.2E-06	1.4E-06
247.5 C	0-16	1.0E-04	2.9E-04	2.7E-05	5.8E-04	4.4E-04	4.0E-05	7.2E-05	1.2E-05	4.6E-06	1.4E-06
247.5 C	14-24	8.8E-05	2.7E-04	2.1E-05	BDL	4.6E-04	3.5E-05	6.2E-05	1.4E-05	3.4E-06	2.3E-06

Table S3B (continued): Elemental abundances (molar ratios, normalized to silicon) in sediment samples.

sample description		*element*									
location[a]	depth (cm)	Rb	Sr	Y	Zr	Ba	La	Ce	Pb	Th	U
Side Canyon Samples											
DD[c]	0-10	7.9E-05	2.3E-04	1.7E-05	BDL	4.7E-04	5.8E-05	8.7E-05	5.3E-06	2.3E-06	1.0E-06
DD	20-30	8.9E-05	2.8E-04	2.0E-05	BDL	4.3E-04	4.2E-05	5.5E-05	7.6E-06	2.7E-06	2.2E-06
DD	47-57	6.7E-05	1.7E-04	9.1E-06	BDL	4.2E-04	3.3E-05	7.2E-05	4.4E-06	2.2E-06	1.5E-06
DD	57-67	9.1E-05	2.7E-04	2.3E-05	6.9E-04	5.1E-04	7.0E-05	1.2E-04	7.8E-06	3.1E-06	2.0E-06
DD	77-87	1.1E-04	4.0E-04	3.1E-05	BDL	4.0E-04	4.7E-05	7.0E-05	1.1E-05	5.6E-06	2.1E-06
DD	102-122	1.0E-04	3.2E-04	2.1E-05	6.6E-04	4.3E-04	3.7E-05	5.8E-05	8.1E-06	3.4E-06	2.3E-06
DD	180-190	1.6E-04	4.2E-04	3.4E-05	BDL	3.5E-04	5.4E-05	1.4E-04	1.3E-05	7.5E-06	3.0E-06
FC A	0-12	8.9E-05	1.2E-04	2.5E-05	8.3E-04	3.4E-04	2.0E-05	5.7E-05	7.5E-06	3.0E-06	1.9E-06
FC A	12-17	8.0E-05	1.0E-04	2.2E-05	8.5E-04	3.8E-04	4.8E-05	1.0E-04	6.9E-06	2.8E-06	1.1E-06
FC A	42.5-52.5	1.0E-04	1.4E-04	2.4E-05	9.8E-04	3.9E-04	9.2E-05	1.2E-04	8.7E-06	3.8E-06	BDL
FC A	57.5-67.5	6.0E-05	7.3E-05	1.5E-05	5.3E-04	2.9E-04	5.8E-05	8.7E-05	5.7E-06	2.2E-06	BDL
FC B	0-4	6.4E-05	8.0E-05	2.2E-05	6.5E-04	2.7E-04	3.3E-05	7.2E-05	4.7E-06	2.3E-06	BDL
FC B	0-8	5.0E-05	6.7E-05	2.4E-05	6.6E-04	2.6E-04	2.2E-05	4.6E-05	5.1E-06	1.9E-06	BDL
FC B	0-8	4.8E-05	6.5E-05	2.2E-05	6.8E-04	2.7E-04	3.8E-05	6.2E-05	4.7E-06	2.0E-06	6.9E-07
FC B	16-24	4.7E-05	6.6E-05	1.8E-05	BDL	2.5E-04	4.5E-05	8.8E-05	5.4E-06	2.0E-06	BDL
FC B	16-24	5.0E-05	7.1E-05	1.8E-05	6.2E-04	2.5E-04	2.8E-05	4.9E-05	4.7E-06	2.2E-06	BDL
WC A	0-10	6.7E-05	1.3E-04	2.0E-05	5.6E-04	3.9E-04	7.6E-05	1.0E-04	1.5E-05	2.0E-06	1.3E-06
WC A	0-12	5.4E-05	9.7E-05	2.6E-05	6.7E-04	2.7E-04	2.5E-05	BDL	5.3E-06	1.7E-06	BDL
WC A	0-14	4.9E-05	8.9E-05	2.3E-05	6.9E-04	2.4E-04	2.6E-05	4.5E-05	4.5E-06	1.9E-06	BDL
WC B	0-8	4.9E-05	9.2E-05	1.9E-05	6.4E-04	2.7E-04	2.2E-05	4.5E-05	5.3E-06	1.8E-06	BDL
WC B	0-8	5.6E-05	1.0E-04	2.4E-05	6.9E-04	2.8E-04	3.9E-05	5.1E-05	5.1E-06	2.3E-06	1.0E-06

Table S3B (continued): Elemental abundances (molar ratios, normalized to silicon) in sediment samples.

sample description		*element*									
location[a]	depth (cm)	Rb	Sr	Y	Zr	Ba	La	Ce	Pb	Th	U
WC C	0-8	1.3E-04	2.8E-04	2.8E-05	BDL	3.5E-04	3.9E-05	7.3E-05	1.4E-05	5.6E-06	3.0E-06
WC C	0-10	1.2E-04	2.5E-04	3.2E-05	BDL	3.3E-04	2.9E-05	7.8E-05	1.2E-05	5.2E-06	3.0E-06
WC C	4-6	1.7E-04	3.2E-04	3.4E-05	BDL	4.1E-04	7.0E-05	8.2E-05	1.7E-05	7.1E-06	3.3E-06
WC C	10-12	1.9E-04	3.7E-04	3.4E-05	BDL	4.7E-04	5.2E-05	1.3E-04	1.9E-05	7.5E-06	3.2E-06
WC C	20-22	5.7E-05	1.1E-04	1.2E-05	7.4E-04	3.3E-04	7.1E-05	6.6E-05	5.3E-06	1.3E-06	BDL
WC D	0-10	3.9E-05	7.6E-05	2.4E-05	8.4E-04	2.3E-04	4.8E-05	7.0E-05	5.2E-06	2.2E-06	BDL
WC D	0-11	3.5E-05	7.2E-05	2.4E-05	5.5E-04	2.0E-04	BDL	3.7E-05	3.1E-06	1.9E-06	BDL
WC D	30-44	2.1E-05	6.6E-05	1.7E-05	6.0E-04	2.3E-04	4.6E-05	6.9E-05	3.2E-06	8.1E-07	BDL
WC E	0-4	3.3E-05	5.9E-05	1.2E-05	4.5E-04	2.1E-04	3.5E-05	5.1E-05	2.5E-06	1.1E-06	BDL
WC E	0-8	2.9E-05	5.6E-05	8.2E-06	4.6E-04	1.8E-04	1.9E-05	4.0E-05	2.9E-06	6.7E-07	BDL
WC E	0-8	3.1E-05	6.0E-05	9.6E-06	4.8E-04	1.8E-04	2.2E-05	3.5E-05	3.5E-06	1.2E-06	BDL
WC E	16-24	4.1E-05	7.3E-05	1.8E-05	6.5E-04	2.5E-04	3.6E-05	4.8E-05	4.4E-06	1.3E-06	BDL
WC E	16-24	4.2E-05	7.0E-05	1.4E-05	4.7E-04	2.4E-04	4.1E-05	6.0E-05	3.7E-06	1.7E-06	BDL
TC A[c]	10-20	1.0E-04	3.0E-04	2.3E-05	BDL	4.9E-04	4.0E-05	7.4E-05	1.2E-05	4.2E-06	2.2E-06
TC A	35-45	1.2E-04	4.3E-04	4.0E-05	BDL	6.1E-04	6.1E-05	1.1E-04	1.8E-05	5.3E-06	3.2E-06
TC A	80-90	5.2E-05	1.3E-04	7.7E-06	BDL	2.9E-04	3.2E-05	6.3E-05	4.9E-06	6.4E-07	8.5E-07
TC A	123-133	1.1E-04	3.2E-04	2.9E-05	BDL	5.3E-04	2.6E-05	8.8E-05	1.6E-05	5.2E-06	3.1E-06
TC A	165-175	6.0E-05	1.3E-04	8.5E-06	5.8E-04	3.5E-04	3.6E-05	4.9E-05	5.5E-06	1.3E-06	BDL
TC A	187.5-197.5	6.7E-05	2.2E-04	1.0E-05	BDL	4.6E-04	5.6E-05	8.0E-05	6.0E-06	1.7E-06	1.7E-06
TC B[c]	7.5-17.5	7.7E-05	1.7E-04	1.2E-05	BDL	4.2E-04	4.6E-05	7.4E-05	6.6E-06	1.5E-06	1.3E-06
TC B	33-43	2.7E-05	9.8E-05	1.0E-05	4.6E-04	2.1E-04	2.6E-05	3.3E-05	2.7E-06	5.6E-07	BDL
TC B	50-58	1.2E-04	4.6E-04	3.8E-05	BDL	6.1E-04	7.9E-05	1.1E-04	2.0E-05	6.2E-06	4.1E-06
MC	0-8	4.5E-05	5.0E-05	6.0E-06	BDL	2.1E-04	2.6E-05	3.5E-05	3.9E-06	1.0E-06	BDL

Table S3B (continued): Elemental abundances (molar ratios, normalized to silicon) in sediment samples.

sample description		*element*									
location[a]	depth (cm)	Rb	Sr	Y	Zr	Ba	La	Ce	Pb	Th	U
SJ	0-5	7.3E-05	1.9E-04	1.9E-05	4.6E-04	3.8E-04	4.2E-05	7.3E-05	8.6E-06	3.2E-06	8.5E-07
SJ	0-6	6.3E-05	1.5E-04	1.7E-05	5.4E-04	3.6E-04	3.1E-05	4.4E-05	7.8E-06	2.6E-06	BDL
SJ	0-8	5.6E-05	1.3E-04	1.4E-05	5.9E-04	3.8E-04	4.0E-05	6.7E-05	4.8E-06	1.9E-06	8.2E-07
SJ	10-15	7.0E-05	1.8E-04	1.8E-05	5.8E-04	3.9E-04	2.7E-05	6.9E-05	6.1E-06	3.1E-06	9.0E-07
SJ	20-25	6.0E-05	1.3E-04	1.3E-05	4.5E-04	3.5E-04	3.3E-05	5.8E-05	5.3E-06	2.0E-06	BDL
SJ	30-35	5.7E-05	1.2E-04	1.5E-05	6.8E-04	4.0E-04	4.4E-05	7.2E-05	5.2E-06	2.2E-06	BDL
NC A	0-12	3.7E-05	3.2E-05	1.8E-05	5.4E-04	1.8E-04	2.3E-05	4.6E-05	2.9E-06	3.8E-07	BDL
NC B	0-8	5.2E-05	5.3E-05	1.1E-05	4.7E-04	2.4E-04	2.6E-05	3.4E-05	4.5E-06	1.4E-06	BDL
NC B	0-12	6.3E-05	7.2E-05	1.8E-05	5.2E-04	2.9E-04	3.3E-05	4.3E-05	4.8E-06	1.6E-06	BDL
median crustal abundance[b]		1.0E-04	4.2E-04	3.7E-05	1.8E-04	1.0E-07	2.2E-06	3.0E-04	6.7E-06	4.1E-06	1.1E-06

[a] "Location" refers to distance from Glen Canyon Dam (in river km) for delta samples and to side canyon location.

[b] Median crustal abundance data from Lide (2007).

[c] For DD and TC side canyon samples only, depth refers to depth below the tops of sets of cores collected above the water line. the water line

Table S4A: Bulk mineral composition (%) of select sediment core sections.

sample description		*non-clay minerals*					
location[a]	depth (cm)	ordered Microcline feldspar	intermediate Microcline feldspar	Sanidine feldspar	Orthoclase feldspar	Albite feldspar (Cleavelandite)	Oligoclase feldspar
Lakebed Samples, March 2006							
245.0	0-16	0.5	2.9	0.5	1.7	1.2	1.2
245.0	60-75	0.0	3.8	0.9	2.1	1.5	1.4
241.2	0-5	0.0	2.9	0.3	2.3	1.5	0.7
238.7	0-12.5	0.4	2.2	0.7	1.6	0.0	1.7
238.7	40-50	0.4	4.9	1.4	2.8	2.8	1.2
235.4	0-15	0.4	1.2	0.9	2.3	1.1	0.8
235.4	25-40	0.0	3.9	0.2	2.8	1.5	1.7
168.0	5-15	0.6	2.7	0.5	0.8	0.8	0.2
Delta Shoreline Samples							
249.5	-132 to -122	2.0	4.2	2.4	1.6	2.4	1.5
249.5	-102 to -94	3.7	4.7	1.1	1.6	1.9	2.0
249.5	-94 to -87	5.6	6.3	1.0	3.1	2.4	3.0
249.5	-77 to -67	3.7	7.4	0.2	2.6	1.6	3.5
249.5	-57 to -47	3.8	6.1	1.0	1.7	2.0	2.7
249.5	-47 to -37	0.1	4.8	0.3	1.8	1.9	1.0
249.5	-12 to -2	0.0	4.9	0.6	1.4	1.8	0.9
249.5	14 to 20	0.0	4.6	0.4	1.8	1.5	0.9
Side Canyon Samples							
FC	0-8	3.7	4.6	2.8	0.6	0.0	0.0
FC	16-24	4.0	4.4	2.4	0.0	0.0	0.0
WC	0-8	2.6	4.0	1.8	0.2	0.0	0.0
WC	16-24	3.6	4.4	2.3	0.6	0.0	0.0
MC	0-8	5.1	7.2	1.4	1.0	0.0	0.0
NC	0-18	4.4	7.4	0.7	2.4	0.2	0.0

Table S4A (continued): Bulk mineral composition (%) of select sediment core sections.

sample description		*non-clay minerals*					
location[a]	depth (cm)	Labradorite feldspar	Calcite	Dolomite	Hematite	Goethite	Maghemite
Lakebed Samples, March 2006							
245.0	0-16	0.0	9.7	5.0	0.3	0.2	1.6
245.0	60-75	0.0	9.5	5.3	0.3	0.3	1.2
241.2	0-5	0.1	9.0	3.9	0.3	0.0	1.5
238.7	0-12.5	0.5	7.5	3.6	0.4	0.3	0.5
238.7	40-50	0.8	9.5	5.9	0.2	0.3	1.3
235.4	0-15	0.0	8.4	3.4	0.1	0.2	1.8
235.4	25-40	0.0	8.7	3.8	0.2	0.1	1.5
168.0	5-15	0.0	10.0	3.8	0.0	0.5	0.0
Delta Shoreline Samples							
249.5	-132 to -122	1.1	9.1	5.6	0.0	0.6	1.5
249.5	-102 to -94	2.8	3.0	1.7	0.2	0.3	0.4
249.5	-94 to -87	3.2	5.5	2.1	0.0	1.0	1.1
249.5	-77 to -67	2.2	5.4	2.1	0.0	0.6	0.0
249.5	-57 to -47	2.4	3.3	1.3	0.0	0.7	0.2
249.5	-47 to -37	1.2	8.3	4.3	0.4	0.2	0.0
249.5	-12 to -2	0.6	8.6	4.1	0.3	0.2	0.0
249.5	14 to 20	0.2	8.6	4.1	0.1	0.2	1.5
Side Canyon Samples							
FC	0-8	0.0	3.0	6.5	0.6	0.3	0.2
FC	16-24	0.0	4.1	7.4	0.6	0.2	0.0
WC	0-8	0.0	2.5	5.1	0.2	0.4	0.0
WC	16-24	0.0	2.8	6.5	0.2	0.3	0.3
MC	0-8	0.0	1.6	0.3	0.2	0.4	0.0
NC	0-18	0.0	0.8	1.0	0.0	0.4	0.0

Table S4A (continued): Bulk mineral composition (%) of select sediment core sections.

sample description		*non-clay minerals*		*clay minerals*			
location[a]	depth (cm)	Apatite	Quartz	disordered Kaolinite	Na-Smectite	Ca-smectite	Ferruginous smectite
Lakebed Samples, March 2006							
245.0	0-16	0.9	19.1	4.3	5.6	0.0	5.7
245.0	60-75	0.8	22.8	4.8	0.1	1.1	7.2
241.2	0-5	0.6	19.0	5.9	0.1	6.5	9.4
238.7	0-12.5	0.6	16.0	6.0	0.1	4.4	8.5
238.7	40-50	0.7	29.0	2.3	0.5	2.6	4.6
235.4	0-15	0.9	18.9	6.8	2.6	0.0	7.4
235.4	25-40	0.4	22.1	3.9	2.1	1.8	5.4
168.0	5-15	0.7	22.0	7.1	2.0	7.3	7.1
Delta Shoreline Samples							
249.5	-132 to -122	0.9	36.5	3.1	0.6	0.0	3.8
249.5	-102 to -94	0.5	73.1	0.5	2.6	0.0	0.0
249.5	-94 to -87	0.4	67.5	0.0	1.5	0.0	0.0
249.5	-77 to -67	0.7	59.4	1.3	2.7	0.0	0.9
249.5	-57 to -47	0.4	70.4	0.1	3.4	0.0	0.0
249.5	-47 to -37	0.2	23.9	3.8	1.4	2.4	6.0
249.5	-12 to -2	0.3	22.6	4.0	1.4	2.3	6.1
249.5	14 to 20	0.8	24.2	4.2	5.7	0.0	4.3
Side Canyon Samples							
FC	0-8	0.6	72.1	1.3	0.0	0.0	0.0
FC	16-24	0.2	72.3	1.5	0.0	0.0	0.0
WC	0-8	0.4	79.7	0.5	1.9	0.0	0.0
WC	16-24	0.4	71.7	1.1	1.8	0.0	0.0
MC	0-8	0.2	75.8	0.5	3.6	0.0	0.5
NC	0-18	0.3	75.9	0.1	1.2	0.0	0.7

Table S4A (continued): Bulk mineral composition (%) of select sediment core sections.

sample description		*clay minerals*					
location[a]	depth (cm)	Illite (1Md) + Dioct. Mica + Smectite)	Illite (1M)	Biotite (1M)	Phlogopite (2M1)	Fe-Chlorite (Tusc)	Mg-Chlorite (Clinochlore)
Lakebed Samples, March 2006							
245.0	0-16	16.1	7.7	0.0	1.5	2.3	2.1
245.0	60-75	13.4	11.2	0.7	0.0	1.5	2.8
241.2	0-5	17.2	7.6	0.9	0.1	2.3	2.9
238.7	0-12.5	9.5	12.3	0.8	0.9	2.3	0.9
238.7	40-50	7.0	9.9	1.2	0.0	3.1	3.3
235.4	0-15	22.7	5.5	0.0	1.5	1.8	0.6
235.4	25-40	19.7	8.1	0.3	0.0	4.1	2.2
168.0	5-15	10.5	9.6	0.0	1.4	2.1	0.0
Delta Shoreline Samples							
249.5	-132 to -122	13.9	7.0	0.7	0.6	2.7	1.1
249.5	-102 to -94	0.0	4.4	0.0	1.2	0.9	0.4
249.5	-94 to -87	0.0	8.1	1.6	0.0	2.8	1.3
249.5	-77 to -67	0.0	5.1	1.4	0.7	0.9	0.3
249.5	-57 to -47	0.0	5.0	1.2	0.0	0.9	1.9
249.5	-47 to -37	10.2	12.6	1.0	0.0	2.3	2.1
249.5	-12 to -2	10.5	12.8	0.9	0.0	2.4	2.4
249.5	14 to 20	16.1	8.9	0.2	0.4	2.3	4.3
Side Canyon Samples							
FC	0-8	1.2	7.4	0.0	0.3	1.0	1.6
FC	16-24	1.5	4.2	0.0	0.8	0.0	0.0
WC	0-8	0.0	3.9	0.0	1.3	0.7	0.3
WC	16-24	0.7	4.8	0.0	0.3	0.7	1.1
MC	0-8	0.0	3.2	0.0	1.2	1.0	0.0
NC	0-18	1.1	4.4	0.6	0.3	0.7	2.3

Table S4A (continued): Bulk mineral composition (%) of select sediment core sections.

sample description		*clay mineral*	*totals*		
location[a]	depth (cm)	Muscovite (2M1)	Total non-clays	Total clays	Total
Lakebed Samples, March 2006					
245.0	0-16	5.7	44.7	51.0	95.7
245.0	60-75	6.9	49.9	49.6	99.5
241.2	0-5	6.9	42.1	59.6	101.7
238.7	0-12.5	7.1	36.1	52.7	88.8
238.7	40-50	3.6	61.2	38.1	99.3
235.4	0-15	7.8	40.3	56.7	97.0
235.4	25-40	5.3	46.8	52.9	99.8
168.0	5-15	5.7	42.5	52.7	95.2
Delta Shoreline Samples					
249.5	-132 to -122	4.5	69.4	38.1	107.5
249.5	-102 to -94	0.0	96.8	10.0	106.9
249.5	-94 to -87	0.0	102.2	15.2	117.4
249.5	-77 to -67	0.0	89.4	13.3	102.6
249.5	-57 to -47	0.0	95.9	12.6	108.5
249.5	-47 to -37	4.1	48.5	45.9	94.4
249.5	-12 to -2	4.3	46.4	47.2	93.5
249.5	14 to 20	5.6	48.7	51.9	100.6
Side Canyon Samples					
FC	0-8	0.5	94.9	13.1	108.0
FC	16-24	1.4	95.5	9.3	104.9
WC	0-8	0.0	96.9	8.7	105.6
WC	16-24	1.0	93.2	11.6	104.8
MC	0-8	0.0	93.3	10.1	103.4
NC	0-18	0.0	93.4	11.4	104.8

[a] "Location" refers to distance from Glen Canyon Dam (in river km) for delta samples and to side canyon location (see Table 1).

Table S4B: Bulk mineral composition (molar ratios, normalized to silica) of select sediment core sections.

sample description		*non-clay minerals*					
location[a]	depth (cm)	ordered Microcline feldspar	intermediate Microcline feldspar	Sanidine feldspar	Orthoclase feldspar	Albite feldspar (Cleavelandite)	Oligoclase feldspar
Lakebed Samples, March 2006							
245.0	0-16	0.006	0.032	0.006	0.019	0.014	0.014
245.0	60-75	0.000	0.036	0.009	0.020	0.015	0.014
241.2	0-5	0.000	0.033	0.003	0.026	0.018	0.008
238.7	0-12.5	0.006	0.030	0.010	0.021	0.000	0.024
238.7	40-50	0.003	0.036	0.011	0.021	0.022	0.010
235.4	0-15	0.004	0.014	0.011	0.026	0.014	0.010
235.4	25-40	0.000	0.038	0.002	0.028	0.015	0.017
168.0	5-15	0.006	0.026	0.005	0.008	0.008	0.002
Delta Shoreline Samples							
249.5	-132 to -122	0.012	0.025	0.014	0.009	0.015	0.010
249.5	-102 to -94	0.011	0.014	0.003	0.005	0.006	0.006
249.5	-94 to -87	0.018	0.020	0.003	0.010	0.008	0.010
249.5	-77 to -67	0.013	0.027	0.001	0.009	0.006	0.013
249.5	-57 to -47	0.012	0.019	0.003	0.005	0.006	0.009
249.5	-47 to -37	0.000	0.043	0.003	0.016	0.018	0.010
249.5	-12 to -2	0.000	0.046	0.006	0.014	0.018	0.009
249.5	14 to -20	0.000	0.041	0.003	0.016	0.015	0.008
Side Canyon Samples							
FC	0-8	0.011	0.014	0.009	0.002	0.000	0.000
FC	16-24	0.012	0.013	0.007	0.000	0.000	0.000
WC	0-8	0.007	0.011	0.005	0.001	0.000	0.000
WC	16-24	0.011	0.013	0.007	0.002	0.000	0.000
MC	0-8	0.015	0.021	0.004	0.003	0.000	0.000
NC	0-18	0.013	0.021	0.002	0.007	0.001	0.000

Table S4B (continued): Bulk mineral composition (molar ratio, normalized to silica) of select sediment core sections.

sample description		*non-clay minerals*					
location[a]	depth (cm)	Labradorite feldspar	Calcite	Dolomite	Hematite	Goethite	Maghemite
Lakebed Samples, March 2006							
245.0	0-16	0.0000	0.305	0.086	0.0054	0.0072	0.032
245.0	60-75	0.0000	0.250	0.076	0.0041	0.0086	0.021
241.2	0-5	0.0011	0.285	0.067	0.0059	0.0013	0.031
238.7	0-12.5	0.0070	0.283	0.073	0.0091	0.0126	0.012
238.7	40-50	0.0059	0.198	0.067	0.0022	0.0076	0.018
235.4	0-15	0.0000	0.266	0.058	0.0023	0.0073	0.035
235.4	25-40	0.0000	0.237	0.056	0.0028	0.0028	0.025
168.0	5-15	0.0000	0.272	0.056	0.0000	0.0160	0.000
Delta Shoreline Samples							
249.5	-132 to -122	0.0065	0.149	0.050	0.0001	0.0109	0.016
249.5	-102 to -94	0.0086	0.024	0.008	0.0008	0.0032	0.002
249.5	-94 to -87	0.0105	0.049	0.010	0.0000	0.0100	0.006
249.5	-77 to -67	0.0083	0.055	0.011	0.0001	0.0071	0.000
249.5	-57 to -47	0.0076	0.028	0.006	0.0000	0.0067	0.001
249.5	-47 to -37	0.0108	0.209	0.059	0.0066	0.0054	0.000
249.5	-12 to -2	0.0062	0.229	0.059	0.0048	0.0055	0.000
249.5	14 to -20	0.0017	0.214	0.055	0.0015	0.0056	0.023
Side Canyon Samples							
FC	0-8	0.0000	0.025	0.029	0.0030	0.0027	0.001
FC	16-24	0.0000	0.034	0.033	0.0032	0.0020	0.000
WC	0-8	0.0000	0.019	0.021	0.0008	0.0030	0.000
WC	16-24	0.0001	0.024	0.030	0.0012	0.0029	0.002
MC	0-8	0.0000	0.013	0.001	0.0011	0.0039	0.000
NC	0-18	0.0000	0.006	0.004	0.0000	0.0032	0.000

Table S4B (continued): Bulk mineral composition (molar ratio, normalized to silica) of select sediment core sections.

sample description		*non-clay minerals*		*clay minerals*			
location[a]	depth (cm)	Apatite	Quartz	disordered Kaolinite	Na-Smectite	Ca-smectite	Ferruginous smectite
Lakebed Samples, March 2006							
245.0	0-16	0.0054	1	0.052	0.0479	0.000	0.046
245.0	60-75	0.0043	1	0.049	0.0007	0.008	0.049
241.2	0-5	0.0035	1	0.072	0.0010	0.055	0.076
238.7	0-12.5	0.0047	1	0.088	0.0009	0.045	0.083
238.7	40-50	0.0027	1	0.018	0.0026	0.014	0.025
235.4	0-15	0.0055	1	0.084	0.0230	0.000	0.061
235.4	25-40	0.0022	1	0.042	0.0155	0.013	0.038
168.0	5-15	0.0037	1	0.075	0.0150	0.054	0.050
Delta Shoreline Samples							
249.5	-132 to -122	0.0030	1	0.020	0.0027	0.000	0.016
249.5	-102 to -94	0.0007	1	0.002	0.0059	0.000	0.000
249.5	-94 to -87	0.0007	1	0.000	0.0036	0.000	0.000
249.5	-77 to -67	0.0013	1	0.005	0.0074	0.000	0.002
249.5	-57 to -47	0.0007	1	0.000	0.0079	0.000	0.000
249.5	-47 to -37	0.0012	1	0.037	0.0099	0.016	0.039
249.5	-12 to -2	0.0016	1	0.042	0.0098	0.016	0.042
249.5	14 to -20	0.0040	1	0.040	0.0385	0.000	0.028
Side Canyon Samples							
FC	0-8	0.0010	1	0.004	0.0000	0.000	0.000
FC	16-24	0.0003	1	0.005	0.0000	0.000	0.000
WC	0-8	0.0006	1	0.002	0.0040	0.000	0.000
WC	16-24	0.0006	1	0.004	0.0041	0.000	0.000
MC	0-8	0.0003	1	0.002	0.0079	0.000	0.001
NC	0-18	0.0005	1	0.000	0.0027	0.000	0.001

Table S4B (continued): Bulk mineral composition (molar ratio, normalized to silica) of select sediment core sections.

sample description		*clay minerals*					
location[a]	depth (cm)	1Md illite (+dioct mica & smectite)	1M illite (R>1, 70-80%I)	Biotite (1M)	Phlogopite (2M1)	Fe-Chlorite (Tusc)	Mg-Chlorite (Clinochlore)
Lakebed Samples, March 2006							
245.0	0-16	0.128	0.061	0.0000	0.011	0.010	0.012
245.0	60-75	0.089	0.074	0.0038	0.000	0.005	0.013
241.2	0-5	0.137	0.060	0.0061	0.001	0.010	0.016
238.7	0-12.5	0.089	0.116	0.0061	0.008	0.012	0.006
238.7	40-50	0.037	0.052	0.0054	0.000	0.009	0.012
235.4	0-15	0.181	0.044	0.0000	0.012	0.008	0.003
235.4	25-40	0.135	0.056	0.0019	0.000	0.015	0.011
168.0	5-15	0.072	0.066	0.0000	0.009	0.008	0.000
Delta Shoreline Samples							
249.5	-132 to -122	0.058	0.029	0.0025	0.002	0.006	0.003
249.5	-102 to -94	0.000	0.009	0.0000	0.002	0.001	0.001
249.5	-94 to -87	0.000	0.018	0.0030	0.000	0.003	0.002
249.5	-77 to -67	0.000	0.013	0.0030	0.002	0.001	0.001
249.5	-57 to -47	0.000	0.011	0.0023	0.000	0.001	0.003
249.5	-47 to -37	0.064	0.079	0.0052	0.000	0.008	0.010
249.5	-12 to -2	0.070	0.085	0.0054	0.000	0.008	0.012
249.5	14 to -20	0.100	0.055	0.0008	0.002	0.008	0.019
Side Canyon Samples							
FC	0-8	0.002	0.015	0.0000	0.001	0.001	0.002
FC	16-24	0.003	0.009	0.0000	0.002	0.000	0.000
WC	0-8	0.000	0.007	0.0000	0.002	0.001	0.000
WC	16-24	0.001	0.010	0.0000	0.001	0.001	0.002
MC	0-8	0.000	0.006	0.0000	0.002	0.001	0.000
NC	0-18	0.002	0.009	0.0010	0.001	0.001	0.003

Table S4B (continued): Bulk mineral composition (molar ratio, normalized to silica) of select sediment core sections.

sample description		*clay mineral*	*totals*	
location[a]	depth (cm)	Muscovite (2M1)	Total non-clays	Total clays
Lakebed Samples, March 2006				
245.0	0-16	0.045	1.532	0.413
245.0	60-75	0.045	1.457	0.337
241.2	0-5	0.055	1.483	0.489
238.7	0-12.5	0.067	1.494	0.521
238.7	40-50	0.019	1.402	0.193
235.4	0-15	0.062	1.454	0.477
235.4	25-40	0.036	1.427	0.362
168.0	5-15	0.039	1.404	0.388
Delta Shoreline Samples				
249.5	-132 to -122	0.019	1.321	0.158
249.5	-102 to -94	0.000	1.092	0.021
249.5	-94 to -87	0.000	1.156	0.030
249.5	-77 to -67	0.000	1.152	0.034
249.5	-57 to -47	0.000	1.103	0.025
249.5	-47 to -37	0.026	1.383	0.294
249.5	-12 to -2	0.029	1.400	0.320
249.5	14 to -20	0.035	1.387	0.328
Side Canyon Samples				
FC	0-8	0.001	1.097	0.027
FC	16-24	0.003	1.105	0.021
WC	0-8	0.000	1.068	0.016
WC	16-24	0.002	1.093	0.025
MC	0-8	0.000	1.061	0.020
NC	0-18	0.000	1.057	0.021

[a] "Location" refers to distance from Glen Canyon Dam (in river km) for delta samples and to side canyon location (see Table 1).

Table S5A: Correlation significance thresholds.

number of samples in each correlation analysis[a]

	size parameters	organic C	total C	elements	minerals
particle size parameters	52	48	45	50	22
organic carbon			73	55	19
total carbon				55	18
elements				71	22
minerals					22

significance thresholds (2σ = 2/√n)

	size parameters	organic C	total C	elements	minerals
particle size parameters	0.277	0.289	0.298	0.283	0.426
organic carbon			0.234	0.270	0.459
total carbon				0.270	0.471
elements				0.237	0.426
minerals					0.426

high significance thresholds (4σ = 4/√n)

	size parameters	organic C	total C	elements	minerals
particle size parameters	0.555	0.577	0.596	0.566	0.853
organic carbon			0.468	0.539	0.918
total carbon				0.539	0.943
elements				0.475	0.853
minerals					0.853

[a] This analysis does not include samples from WC C, TC A, or TC B, which contained visible plant debris.

Table S5B: Correlation coefficients derived from elemental concentrations expressed as mass percentages[a].

	median	log (median)	mean	log (mean)	mode	log (mode)	organic C	total C	Mg	Al
median	1	**0.845**	**0.996**	**0.843**	**0.965**	**0.771**	**-0.692**	**-0.531**	**-0.771**	**-0.780**
log (median)		1	**0.835**	**0.986**	**0.838**	**0.944**	**-0.900**	**-0.708**	**-0.834**	**-0.935**
mean			1	**0.846**	**0.979**	**0.782**	**-0.680**	**-0.519**	**-0.749**	**-0.759**
log (mean)				1	**0.872**	**0.981**	**-0.878**	**-0.697**	**-0.811**	**-0.905**
mode					1	**0.837**	**-0.689**	**-0.534**	**-0.736**	**-0.728**
log (mode)						1	**-0.832**	**-0.687**	**-0.745**	**-0.846**
organic C							1	**0.659**	**0.730**	**0.821**
total C								1	**0.458**	**0.523**
Mg									1	**0.785**
Al										1

[a] Significant correlations (≥ 2σ from 0) are in bold text; highly significant correlations (≥ 4σ from 0) are in bold and red text.

Table S5B: Correlation coefficients derived from elemental concentrations expressed as mass percentages (continued).

	Si	P	S	Cl	K	Ca	Ti	V	Cr	Mn	Fe	Ni
median	**0.687**	**-0.610**	**-0.450**	-0.167	**-0.764**	**-0.504**	**-0.841**	**-0.657**	**-0.322**	**-0.697**	**-0.724**	**-0.808**
log (median)	**0.871**	**-0.846**	**-0.489**	-0.037	**-0.635**	**-0.676**	**-0.936**	**-0.937**	**-0.336**	**-0.890**	**-0.962**	**-0.890**
mean	**0.668**	**-0.598**	**-0.430**	-0.142	**-0.745**	**-0.477**	**-0.820**	**-0.647**	**-0.329**	**-0.675**	**-0.706**	**-0.779**
log (mean)	**0.838**	**-0.822**	**-0.455**	-0.006	**-0.621**	**-0.636**	**-0.914**	**-0.918**	**-0.346**	**-0.859**	**-0.933**	**-0.850**
mode	**0.654**	**-0.608**	**-0.371**	-0.051	**-0.683**	**-0.472**	**-0.799**	**-0.660**	**-0.313**	**-0.669**	**-0.698**	**-0.741**
log (mode)	**0.772**	**-0.778**	**-0.386**	0.043	**-0.555**	**-0.571**	**-0.847**	**-0.891**	**-0.316**	**-0.793**	**-0.885**	**-0.781**
organic C	**-0.746**	**0.863**	**0.523**	0.083	**0.440**	**0.678**	**0.812**	**0.864**	0.257	**0.873**	**0.883**	**0.802**
total C	**-0.628**	**0.648**	**0.331**	-0.014	0.180	**0.503**	**0.537**	**0.600**	0.153	**0.710**	**0.611**	**0.556**
Mg	**-0.479**	**0.610**	**0.328**	0.122	**0.638**	**0.783**	**0.839**	**0.703**	0.031	**0.750**	**0.776**	**0.797**
Al	**-0.615**	**0.740**	**0.503**	0.082	**0.796**	**0.568**	**0.971**	**0.888**	0.127	**0.830**	**0.955**	**0.887**
Si	1	**-0.685**	**-0.673**	-0.224	**-0.281**	**-0.607**	**-0.633**	**-0.661**	**-0.499**	**-0.645**	**-0.708**	**-0.674**
P		1	**0.539**	0.109	**0.337**	**0.714**	**0.712**	**0.824**	0.162	**0.844**	**0.784**	**0.709**
S			1	**0.361**	**0.338**	**0.381**	**0.498**	**0.453**	**0.268**	**0.487**	**0.498**	**0.510**
Cl				1	0.104	0.235	0.120	0.017	**0.456**	0.057	0.081	0.106
K					1	0.231	**0.797**	**0.504**	0.042	**0.501**	**0.651**	**0.697**
Ca						1	**0.628**	**0.618**	0.123	**0.712**	**0.640**	**0.626**
Ti							1	**0.850**	0.162	**0.844**	**0.936**	**0.889**
V								1	0.145	**0.833**	**0.952**	**0.812**
Cr									1	0.042	0.165	0.223
Mn										1	**0.870**	**0.762**
Fe											1	**0.885**
Ni												1

Table S5B: Correlation coefficients derived from elemental concentrations expressed as mass percentages (continued).

	Cu	Zn	Ga	As	Se	Br	Rb	Sr	Y	Zr	Ba
median	-0.126	**-0.653**	**-0.715**	**-0.607**	**-0.492**	**-0.627**	**-0.774**	**-0.541**	**-0.674**	**0.604**	0.054
log (median)	**-0.498**	**-0.942**	**-0.953**	**-0.880**	**-0.678**	**-0.850**	**-0.975**	**-0.815**	**-0.778**	**0.829**	0.037
mean	-0.092	**-0.639**	**-0.699**	**-0.585**	**-0.482**	**-0.612**	**-0.764**	**-0.529**	**-0.660**	**0.584**	0.045
log (mean)	**-0.453**	**-0.917**	**-0.924**	**-0.840**	**-0.650**	**-0.828**	**-0.958**	**-0.783**	**-0.770**	**0.787**	0.027
mode	-0.111	**-0.652**	**-0.689**	**-0.569**	**-0.465**	**-0.612**	**-0.762**	**-0.520**	**-0.685**	**0.569**	0.048
log (mode)	**-0.431**	**-0.883**	**-0.883**	**-0.782**	**-0.623**	**-0.776**	**-0.920**	**-0.730**	**-0.743**	**0.734**	0.058
organic C	0.226	**0.893**	**0.855**	**0.840**	**0.612**	**0.867**	**0.881**	**0.842**	**0.596**	**-0.849**	0.119
total C	**0.277**	**0.629**	**0.548**	**0.602**	**0.435**	**0.627**	**0.553**	**0.587**	**0.451**	**-0.525**	0.080
Mg	**0.386**	**0.731**	**0.729**	**0.778**	**0.501**	**0.594**	**0.715**	**0.538**	**0.753**	**-0.491**	-0.216
Al	**0.299**	**0.877**	**0.954**	**0.890**	**0.604**	**0.719**	**0.950**	**0.781**	**0.711**	**-0.660**	0.096
Si	**-0.256**	**-0.613**	**-0.638**	**-0.652**	**-0.503**	**-0.580**	**-0.652**	**-0.665**	**-0.298**	**0.695**	0.008
P	**0.257**	**0.833**	**0.770**	**0.761**	**0.614**	**0.789**	**0.769**	**0.876**	**0.663**	**-0.671**	**0.240**
S	0.142	**0.410**	**0.462**	**0.432**	**0.397**	**0.484**	**0.480**	**0.501**	0.208	**-0.485**	0.082
Cl	-0.018	-0.012	0.086	0.109	0.087	0.140	0.050	0.082	-0.046	-0.059	0.025
K	0.156	**0.496**	**0.669**	**0.593**	**0.352**	**0.375**	**0.685**	**0.346**	**0.568**	**-0.315**	0.048
Ca	**0.364**	**0.645**	**0.570**	**0.675**	**0.427**	**0.517**	**0.546**	**0.694**	**0.573**	**-0.549**	0.007
Ti	**0.315**	**0.850**	**0.918**	**0.865**	**0.592**	**0.690**	**0.919**	**0.736**	**0.760**	**-0.620**	0.058
V	**0.343**	**0.957**	**0.936**	**0.901**	**0.655**	**0.774**	**0.943**	**0.867**	**0.654**	**-0.766**	0.069
Cr	-0.035	0.067	0.135	0.138	0.107	0.064	0.142	0.121	-0.110	-0.164	0.057
Mn	**0.377**	**0.871**	**0.829**	**0.852**	**0.589**	**0.856**	**0.805**	**0.829**	**0.721**	**-0.698**	0.138
Fe	**0.342**	**0.934**	**0.980**	**0.951**	**0.655**	**0.777**	**0.968**	**0.846**	**0.694**	**-0.759**	0.024
Ni	**0.286**	**0.799**	**0.858**	**0.839**	**0.547**	**0.673**	**0.856**	**0.679**	**0.681**	**-0.663**	-0.064
Cu	1	**0.493**	**0.284**	**0.393**	0.149	**0.363**	**0.264**	**0.239**	**0.324**	-0.188	-0.013
Zn		1	**0.917**	**0.904**	**0.632**	**0.814**	**0.920**	**0.859**	**0.706**	**-0.718**	0.118
Ga			1	**0.926**	**0.644**	**0.759**	**0.973**	**0.838**	**0.694**	**-0.728**	0.067

Table S5B: Correlation coefficients derived from elemental concentrations expressed as mass percentages (continued).

	La	Ce	Pb	Th	U	ordered Microcline feldspar	intermediate Microcline feldspar	Sanidine feldspar	Orthoclase feldspar
median	0.012	-0.147	**-0.614**	**-0.758**	**-0.612**	**0.812**	**0.658**	0.118	0.035
log (median)	0.004	-0.264	**-0.881**	**-0.964**	**-0.855**	**0.928**	**0.727**	0.411	-0.178
mean	0.007	-0.148	**-0.597**	**-0.744**	**-0.596**	**0.813**	**0.655**	0.125	0.037
log (mean)	-0.022	-0.281	**-0.849**	**-0.946**	**-0.832**	**0.898**	**0.743**	0.385	-0.164
mode	-0.021	-0.179	**-0.587**	**-0.749**	**-0.589**	**0.789**	**0.673**	0.114	0.034
log (mode)	-0.038	**-0.302**	**-0.806**	**-0.907**	**-0.806**	**0.829**	**0.743**	0.390	-0.128
organic C	-0.001	0.207	**0.800**	**0.882**	**0.771**	**-0.879**	**-0.600**	**-0.532**	0.300
total C	0.041	0.130	**0.606**	**0.637**	**0.607**	**-0.896**	**-0.764**	-0.181	0.178
Mg	0.020	0.174	**0.646**	**0.757**	**0.632**	**-0.858**	**-0.772**	-0.110	0.055
Al	0.072	**0.320**	**0.873**	**0.931**	**0.818**	**-0.896**	**-0.706**	**-0.447**	0.296
Si	-0.083	-0.212	**-0.574**	**-0.637**	**-0.721**	**0.917**	**0.674**	**0.431**	-0.261
P	0.106	**0.247**	**0.776**	**0.798**	**0.817**	**-0.835**	**-0.548**	**-0.481**	**0.470**
S	0.000	0.088	**0.452**	**0.435**	**0.594**	**-0.748**	-0.372	**-0.503**	0.370
Cl	0.095	0.143	-0.022	0.027	0.135	-0.135	-0.282	0.117	-0.212
K	0.103	**0.258**	**0.601**	**0.609**	**0.480**	**-0.648**	**-0.591**	-0.127	0.101
Ca	0.035	0.166	**0.556**	**0.631**	**0.633**	**-0.761**	**-0.607**	-0.113	0.172
Ti	0.075	**0.342**	**0.824**	**0.924**	**0.797**	**-0.909**	**-0.728**	-0.305	0.213
V	0.029	**0.312**	**0.879**	**0.944**	**0.890**	**-0.920**	**-0.663**	**-0.559**	0.379
Cr	0.156	**0.258**	0.009	0.116	0.185	**-0.655**	-0.293	**-0.569**	0.394
Mn	0.081	**0.258**	**0.853**	**0.873**	**0.821**	**-0.901**	**-0.644**	-0.343	0.328
Fe	0.035	**0.314**	**0.888**	**0.961**	**0.872**	**-0.934**	**-0.708**	**-0.508**	0.340
Ni	0.073	**0.290**	**0.761**	**0.853**	**0.756**	**-0.885**	**-0.697**	-0.313	0.121
Cu	**0.348**	**0.366**	**0.510**	**0.309**	**0.315**	**-0.949**	**-0.745**	**-0.428**	0.203
Zn	0.116	**0.347**	**0.926**	**0.939**	**0.834**	**-0.929**	**-0.656**	**-0.570**	0.379
Ga	0.010	**0.303**	**0.870**	**0.953**	**0.844**	**-0.911**	**-0.715**	**-0.550**	0.309

Table S5B: Correlation coefficients derived from elemental concentrations expressed as mass percentages (continued).

	Albite feldspar (Cleavelandite)	Oligoclase feldspar	Labradorite feldspar	Calcite	Dolomite	Hematite	Goethite
median	0.040	**0.475**	**0.717**	**-0.711**	**-0.504**	-0.355	**0.668**
log (median)	-0.161	0.184	**0.504**	**-0.869**	-0.311	-0.184	**0.572**
mean	0.054	**0.477**	**0.728**	**-0.705**	**-0.494**	-0.348	**0.669**
log (mean)	-0.127	0.198	**0.505**	**-0.840**	-0.302	-0.199	**0.570**
mode	0.053	**0.487**	**0.703**	**-0.688**	**-0.476**	-0.370	**0.662**
log (mode)	-0.072	0.210	**0.465**	**-0.771**	-0.237	-0.194	**0.526**
organic C	0.273	-0.083	-0.404	**0.878**	0.158	0.110	**-0.507**
total C	0.434	-0.063	-0.296	**0.932**	**0.586**	0.207	-0.425
Mg	0.175	-0.154	**-0.492**	**0.861**	**0.655**	0.312	**-0.517**
Al	0.339	0.062	-0.292	**0.942**	0.281	0.101	**-0.427**
Si	-0.417	-0.100	0.226	**-0.943**	-0.362	-0.152	**0.427**
P	**0.557**	0.241	-0.084	**0.955**	0.236	-0.047	-0.258
S	**0.469**	0.133	-0.172	**0.877**	0.075	-0.151	-0.196
Cl	-0.229	-0.323	**-0.485**	0.172	**0.466**	0.389	**-0.426**
K	0.026	-0.167	**-0.475**	**0.685**	0.361	0.412	**-0.511**
Ca	**0.518**	0.169	-0.101	**0.878**	**0.633**	0.171	-0.265
Ti	0.289	-0.066	-0.402	**0.927**	**0.454**	0.233	**-0.512**
V	0.373	0.084	-0.253	**0.920**	0.167	0.040	-0.420
Cr	0.327	0.349	-0.091	**0.738**	0.081	-0.079	-0.233
Mn	**0.438**	0.085	-0.264	**0.919**	**0.468**	0.233	**-0.493**
Fe	0.352	0.077	-0.287	**0.938**	0.263	0.128	**-0.478**
Ni	0.242	-0.152	**-0.432**	**0.907**	0.408	0.193	**-0.473**
Cu	0.249	0.027	-0.374	**0.851**	0.347	0.199	**-0.609**
Zn	0.373	0.084	-0.273	**0.936**	0.195	0.067	**-0.456**
Ga	0.298	0.051	-0.287	**0.898**	0.175	0.091	**-0.476**

Table S5B: Correlation coefficients derived from elemental concentrations expressed as mass percentages (continued).

	Maghemite	Apatite	Quartz	Total non-clays	disordered Kaolinite	Na-Smectite	Ca-smectite
median	**-0.439**	-0.341	**0.796**	**0.833**	**-0.792**	0.145	**-0.477**
log (median)	**-0.518**	**-0.447**	**0.958**	**0.978**	**-0.934**	0.047	**-0.604**
mean	-0.423	-0.335	**0.796**	**0.836**	**-0.795**	0.146	**-0.488**
log (mean)	**-0.484**	-0.407	**0.937**	**0.962**	**-0.925**	0.089	**-0.636**
mode	-0.409	-0.289	**0.784**	**0.826**	**-0.788**	0.188	**-0.518**
log (mode)	-0.370	-0.314	**0.879**	**0.917**	**-0.907**	0.133	**-0.703**
organic C	**0.592**	**0.481**	**-0.930**	**-0.932**	**0.831**	0.053	**0.613**
total C	**0.644**	**0.518**	**-0.897**	**-0.845**	**0.776**	-0.218	**0.515**
Mg	**0.590**	**0.528**	**-0.842**	**-0.820**	**0.794**	-0.161	**0.480**
Al	**0.591**	**0.527**	**-0.971**	**-0.948**	**0.915**	-0.044	**0.631**
Si	**-0.562**	**-0.506**	**0.955**	**0.920**	**-0.858**	0.003	**-0.493**
P	**0.603**	**0.561**	**-0.930**	**-0.864**	**0.793**	-0.043	**0.568**
S	**0.452**	**0.475**	**-0.847**	**-0.804**	**0.717**	0.102	**0.611**
Cl	0.178	0.076	-0.115	-0.130	0.177	-0.099	0.129
K	**0.484**	0.354	**-0.759**	**-0.759**	**0.752**	-0.175	**0.442**
Ca	**0.571**	**0.548**	**-0.750**	**-0.661**	**0.609**	-0.112	0.359
Ti	**0.597**	**0.514**	**-0.948**	**-0.926**	**0.880**	-0.118	**0.552**
V	**0.557**	**0.477**	**-0.983**	**-0.970**	**0.905**	-0.001	**0.617**
Cr	0.314	**0.544**	**-0.738**	**-0.694**	**0.666**	0.044	0.403
Mn	**0.648**	**0.496**	**-0.913**	**-0.862**	**0.748**	-0.044	0.400
Fe	**0.604**	**0.506**	**-0.991**	**-0.974**	**0.911**	-0.017	**0.579**
Ni	**0.478**	**0.493**	**-0.920**	**-0.914**	**0.899**	-0.108	**0.624**
Cu	**0.597**	**0.545**	**-0.922**	**-0.924**	**0.862**	0.052	**0.442**
Zn	**0.576**	**0.468**	**-0.990**	**-0.974**	**0.905**	-0.001	**0.603**
Ga	**0.552**	**0.476**	**-0.976**	**-0.975**	**0.940**	-0.016	**0.656**

Table S5B: Correlation coefficients derived from elemental concentrations expressed as mass percentages (continued).

	Ferruginous smectite	Illite (1Md) + Dioct. Mica + Smectite	Illite (1M)	Biotite (1M)	Phlogopite (2M1)	Fe-Chlorite (Tusc)	Mg-Chlorite (Clinochlore)
median	**-0.791**	**-0.786**	**-0.603**	0.272	-0.002	**-0.526**	-0.384
log (median)	**-0.946**	**-0.895**	**-0.721**	0.085	-0.010	**-0.660**	-0.402
mean	**-0.796**	**-0.783**	**-0.593**	0.267	-0.013	**-0.522**	-0.365
log (mean)	**-0.940**	**-0.872**	**-0.688**	0.087	-0.051	**-0.663**	-0.318
mode	**-0.795**	**-0.767**	**-0.596**	0.268	-0.018	**-0.537**	-0.328
log (mode)	**-0.908**	**-0.796**	**-0.649**	0.094	-0.110	**-0.622**	-0.181
organic C	**0.901**	**0.843**	**0.668**	-0.012	0.074	**0.699**	0.406
total C	**0.818**	**0.781**	**0.772**	-0.015	-0.055	**0.684**	0.422
Mg	**0.787**	**0.791**	**0.632**	-0.104	-0.034	**0.623**	0.359
Al	**0.921**	**0.879**	**0.730**	0.056	-0.041	**0.751**	0.381
Si	**-0.887**	**-0.850**	**-0.779**	-0.151	0.128	**-0.658**	**-0.474**
P	**0.831**	**0.793**	**0.770**	0.255	-0.193	**0.812**	**0.485**
S	**0.772**	**0.677**	**0.652**	0.194	-0.022	**0.763**	0.337
Cl	0.151	0.206	-0.174	-0.311	0.164	-0.111	-0.028
K	**0.730**	**0.733**	**0.569**	-0.141	-0.038	**0.557**	0.268
Ca	**0.619**	**0.642**	**0.645**	0.156	-0.189	**0.631**	0.412
Ti	**0.891**	**0.880**	**0.735**	-0.005	-0.081	**0.718**	**0.427**
V	**0.940**	**0.882**	**0.773**	0.119	-0.072	**0.771**	**0.431**
Cr	**0.677**	**0.610**	**0.514**	0.277	-0.010	**0.470**	0.197
Mn	**0.812**	**0.830**	**0.724**	0.126	-0.160	**0.740**	**0.519**
Fe	**0.948**	**0.902**	**0.758**	0.096	-0.064	**0.741**	**0.438**
Ni	**0.878**	**0.834**	**0.727**	-0.062	-0.003	**0.646**	0.368
Cu	**0.878**	**0.890**	**0.646**	-0.047	-0.027	**0.587**	**0.471**
Zn	**0.945**	**0.901**	**0.761**	0.113	-0.081	**0.767**	**0.441**
Ga	**0.963**	**0.893**	**0.726**	0.057	-0.030	**0.696**	0.394

Table S5B: Correlation coefficients derived from elemental concentrations expressed as mass percentages (continued).

	Muscovite (2M1)	Total clays	total
median	**-0.839**	**-0.815**	0.705
log (median)	**-0.959**	**-0.969**	0.789
mean	**-0.835**	**-0.813**	0.722
log (mean)	**-0.934**	**-0.946**	0.801
mode	**-0.822**	**-0.804**	0.711
log (mode)	**-0.870**	**-0.889**	0.801
organic C	**0.878**	**0.924**	**-0.776**
total C	**0.857**	**0.862**	**-0.584**
Mg	**0.860**	**0.830**	**-0.606**
Al	**0.940**	**0.963**	**-0.690**
Si	**-0.908**	**-0.933**	**0.676**
P	**0.836**	**0.896**	**-0.570**
S	**0.722**	**0.809**	**-0.610**
Cl	0.206	0.122	-0.125
K	**0.796**	**0.759**	**-0.590**
Ca	**0.687**	**0.698**	-0.398
Ti	**0.931**	**0.938**	**-0.681**
V	**0.927**	**0.978**	**-0.727**
Cr	**0.624**	**0.678**	**-0.591**
Mn	**0.848**	**0.875**	**-0.631**
Fe	**0.954**	**0.982**	**-0.729**
Ni	**0.903**	**0.917**	**-0.698**
Cu	**0.926**	**0.922**	**-0.723**
Zn	**0.937**	**0.984**	**-0.725**
Ga	**0.957**	**0.984**	**-0.731**

Table S5B: Correlation coefficients derived from elemental concentrations expressed as mass percentages (continued).

	As	Se	Br	Rb	Sr	Y	Zr	Ba
As	1	**0.628**	**0.786**	**0.897**	**0.817**	**0.664**	**-0.733**	0.031
Se		1	**0.574**	**0.638**	**0.560**	**0.516**	**-0.585**	-0.108
Br			1	**0.728**	**0.731**	**0.560**	**-0.666**	0.094
Rb				1	**0.837**	**0.670**	**-0.741**	0.104
Sr					1	**0.547**	**-0.756**	**0.362**
Y						1	**-0.300**	-0.005
Zr							1	-0.001
Ba								1

Table S5B: Correlation coefficients derived from elemental concentrations expressed as mass percentages (continued).

	La	Ce	Pb	Th	U	ordered Microcline feldspar	intermediate Microcline feldspar	Sanidine feldspar	Orthoclase feldspar
As	0.038	**0.307**	**0.847**	**0.908**	**0.810**	**-0.876**	**-0.659**	**-0.474**	0.411
Se	-0.078	0.126	**0.558**	**0.610**	**0.648**	**-0.715**	-0.332	**-0.433**	0.407
Br	-0.001	0.158	**0.783**	**0.762**	**0.713**	**-0.846**	**-0.675**	**-0.495**	0.296
Rb	0.038	**0.308**	**0.874**	**0.958**	**0.847**	**-0.901**	**-0.676**	**-0.538**	0.310
Sr	0.031	**0.263**	**0.832**	**0.849**	**0.839**	**-0.835**	**-0.514**	**-0.579**	**0.526**
Y	-0.009	0.211	**0.641**	**0.732**	**0.588**	**-0.780**	**-0.608**	-0.269	0.280
Zr	0.018	-0.182	**-0.674**	**-0.721**	**-0.762**	**0.793**	**0.471**	**0.500**	-0.300
Ba	**0.316**	**0.307**	**0.267**	0.086	0.106	0.003	0.170	-0.171	**0.587**
La	1	**0.651**	0.177	0.034	0.069	-0.300	-0.132	-0.035	0.284
Ce		1	**0.379**	**0.354**	**0.289**	**-0.599**	-0.334	-0.335	0.287
Pb			1	**0.867**	**0.829**	**-0.832**	**-0.512**	**-0.639**	**0.518**
Th				1	**0.842**	**-0.910**	**-0.724**	-0.424	0.259
U					1	**-0.825**	**-0.510**	**-0.465**	**0.440**
ordered Microcline feldspar						1	**0.689**	**0.476**	-0.203
intermediate Microcline feldspar							1	0.04	0.154
Sanidine feldspar								1	**-0.615**
Orthoclase feldspar									1

Table S5B: Correlation coefficients derived from elemental concentrations expressed as mass percentages (continued).

	Albite feldspar (Cleavelandite)	Oligoclase feldspar	Labradorite feldspar	Calcite	Dolomite	Hematite	Goethite
As	**0.427**	0.240	-0.175	**0.921**	0.278	0.148	**-0.429**
Se	0.218	0.006	-0.349	**0.687**	0.168	0.035	-0.382
Br	0.279	0.019	-0.361	**0.847**	0.243	0.142	**-0.551**
Rb	0.268	0.007	-0.342	**0.900**	0.169	0.099	**-0.468**
Sr	**0.661**	0.389	0.060	**0.938**	0.105	-0.089	-0.240
Y	0.241	-0.120	-0.361	**0.776**	**0.429**	0.219	**-0.493**
Zr	-0.349	-0.007	0.290	**-0.814**	-0.004	0.041	0.375
Ba	**0.790**	**0.767**	**0.763**	0.225	-0.195	-0.161	0.261
La	0.420	0.131	0.156	0.349	0.177	0.192	-0.252
Ce	0.281	0.149	-0.006	**0.489**	0.088	0.177	-0.362
Pb	**0.536**	0.316	-0.019	**0.899**	0.065	-0.010	-0.321
Th	0.332	0.013	-0.309	**0.931**	0.297	0.153	**-0.469**
U	**0.472**	0.151	-0.143	**0.899**	0.202	0.010	-0.286
ordered Microcline feldspar	-0.272	0.076	0.414	**-0.860**	-0.343	-0.163	**0.622**
intermediate Microcline feldspar	0.096	0.242	**0.438**	**-0.596**	**-0.483**	-0.296	**0.502**
Sanidine feldspar	-0.345	-0.404	-0.133	**-0.449**	**0.526**	0.331	0.146
Orthoclase feldspar	**0.674**	**0.641**	0.394	0.375	-0.420	**-0.460**	0.160
Albite feldspar (Cleavelandite)	1	**0.659**	**0.609**	**0.529**	-0.124	-0.397	0.246
Oligoclase feldspar		1	**0.814**	0.188	-0.395	-0.410	0.516

Table S5B: Correlation coefficients derived from elemental concentrations expressed as mass percentages (continued).

	Maghemite	Apatite	Quartz	Total non-clays	disordered Kaolinite	Na-Smectite	Ca-smectite
As	**0.660**	**0.577**	**-0.942**	**-0.896**	**0.832**	-0.069	**0.519**
Se	0.382	**0.544**	**-0.763**	**-0.750**	**0.681**	-0.109	0.413
Br	**0.676**	**0.508**	**-0.883**	**-0.875**	**0.804**	0.132	**0.553**
Rb	**0.530**	**0.455**	**-0.982**	**-0.984**	**0.933**	-0.006	**0.623**
Sr	**0.628**	**0.538**	**-0.923**	**-0.852**	**0.742**	0.092	**0.470**
Y	**0.475**	**0.451**	**-0.823**	**-0.805**	**0.773**	-0.286	**0.518**
Zr	**-0.519**	-0.395	**0.868**	**0.864**	**-0.765**	-0.148	**-0.494**
Ba	0.335	0.117	-0.134	0.006	-0.124	0.070	-0.156
La	0.133	0.045	-0.340	-0.281	0.225	**-0.429**	0.372
Ce	0.086	0.126	**-0.597**	-0.591	**0.505**	-0.328	**0.613**
Pb	**0.585**	**0.427**	**-0.937**	**-0.889**	**0.777**	0.130	**0.489**
Th	**0.561**	**0.491**	**-0.967**	**-0.952**	**0.904**	-0.065	**0.630**
U	**0.472**	0.417	**-0.913**	**-0.866**	**0.785**	-0.149	**0.590**
ordered Microcline feldspar	**-0.491**	**-0.458**	**0.931**	**0.943**	**-0.854**	-0.004	**-0.550**
intermediate Microcline feldspar	**-0.486**	**-0.507**	**0.649**	**0.692**	**-0.801**	0.112	**-0.446**
Sanidine feldspar	-0.190	-0.098	**0.558**	**0.566**	**-0.443**	-0.369	-0.411
Orthoclase feldspar	**0.548**	0.270	-0.374	-0.274	0.126	0.061	0.063
Albite feldspar (Cleavelandite)	**0.462**	0.294	-0.365	-0.214	0.071	0.081	0.053
Oligoclase feldspar	0.208	0.214	-0.087	0.044	-0.117	0.153	-0.123

Table S5B: Correlation coefficients derived from elemental concentrations expressed as mass percentages (continued).

	Ferruginous smectite	Illite (1Md) + Dioct. Mica + Smectite	Illite (1M)	Biotite (1M)	Phlogopite (2M1)	Fe-Chlorite (Tusc)	Mg-Chlorite (Clinochlore)
As	**0.893**	**0.848**	**0.690**	0.205	-0.112	**0.697**	**0.449**
Se	**0.723**	**0.684**	**0.616**	0.159	-0.146	**0.532**	**0.484**
Br	**0.858**	**0.855**	**0.540**	-0.025	0.020	**0.682**	**0.457**
Rb	**0.960**	**0.888**	**0.749**	0.041	-0.008	**0.713**	0.377
Sr	**0.824**	**0.786**	**0.739**	0.333	-0.161	**0.792**	**0.480**
Y	**0.788**	**0.751**	**0.714**	0.029	-0.202	**0.590**	**0.471**
Zr	**-0.841**	**-0.791**	**-0.601**	-0.050	-0.072	**-0.699**	-0.332
Ba	-0.014	0.063	0.206	**0.594**	-0.418	0.413	0.246
La	0.328	0.221	0.378	0.265	-0.335	0.418	0.121
Ce	**0.595**	0.380	**0.607**	0.316	-0.248	**0.501**	0.264
Pb	**0.838**	**0.805**	**0.767**	0.277	-0.167	**0.810**	**0.484**
Th	**0.926**	**0.862**	**0.746**	0.028	-0.012	**0.734**	0.372
U	**0.847**	**0.753**	**0.804**	0.298	-0.168	**0.819**	0.375
ordered Microcline feldspar	**-0.897**	**-0.850**	**-0.714**	0.015	0.070	**-0.616**	**-0.513**
intermediate Microcline feldspar	**-0.694**	**-0.699**	-0.344	0.396	-0.355	-0.313	-0.005
Sanidine feldspar	**-0.548**	-0.437	-0.398	-0.350	0.072	**-0.443**	-0.339
Orthoclase feldspar	0.308	0.342	0.263	**0.657**	-0.409	**0.601**	**0.471**
Albite feldspar (Cleavelandite)	0.217	0.275	0.359	**0.640**	-0.424	**0.586**	**0.437**
Oligoclase feldspar	-0.026	-0.040	0.134	**0.700**	-0.237	0.289	0.048

Table S5B: Correlation coefficients derived from elemental concentrations expressed as mass percentages (continued).

	Muscovite (2M1)	Total clays	total
As	**0.907**	**0.916**	**-0.634**
Se	**0.687**	**0.741**	**-0.611**
Br	**0.861**	**0.898**	**-0.607**
Rb	**0.953**	**0.981**	**-0.776**
Sr	**0.812**	**0.881**	**-0.570**
Y	**0.806**	**0.814**	**-0.597**
Zr	**-0.817**	-0.862	**0.679**
Ba	-0.026	0.063	0.223
La	0.225	0.285	-0.207
Ce	**0.474**	**0.543**	**-0.614**
Pb	**0.826**	**0.905**	**-0.640**
Th	**0.935**	**0.955**	**-0.730**
U	**0.796**	**0.872**	**-0.658**
ordered Microcline feldspar	**-0.897**	**-0.927**	**0.784**
intermediate Microcline feldspar	**-0.789**	**-0.694**	**0.530**
Sanidine feldspar	-0.418	**-0.553**	**0.483**
Orthoclase feldspar	0.241	0.346	0.013
Albite feldspar (Cleavelandite)	0.177	0.302	0.110
Oligoclase feldspar	-0.067	0.006	0.189

Table S5B: Correlation coefficients derived from elemental concentrations expressed as mass percentages (continued).

	Labradorite feldspar	Calcite	Dolomite	Hematite	Goethite
Labradorite feldspar	1	-0.155	**-0.454**	-0.387	**0.668**
Calcite		1	0.320	-0.009	-0.286
Dolomite			1	**0.579**	-0.38
Hematite				1	**-0.588**
Goethite					1

Table S5B: Correlation coefficients derived from elemental concentrations expressed as mass percentages (continued).

	Maghemite	Apatite	Quartz	Total non-clays	disordered Kaolinite	Na-Smectite	Ca-smectite
Labradorite feldspar	-0.101	-0.097	0.288	0.406	**-0.440**	0.081	-0.218
Calcite	**0.629**	**0.596**	**-0.943**	**-0.877**	**0.824**	0.000	**0.530**
Dolomite	0.178	0.224	-0.21	-0.185	0.230	-0.376	0.053
Hematite	-0.156	-0.241	-0.057	-0.104	0.108	-0.391	0.075
Goethite	-0.208	-0.032	**0.454**	**0.546**	**-0.486**	0.040	-0.269
Maghemite	1	**0.683**	**-0.585**	**-0.509**	**0.457**	0.167	0.016
Apatite		1	**-0.526**	**-0.467**	**0.531**	0.191	0.081
Quartz			1	**0.982**	**-0.910**	-0.024	**-0.581**
Total non-clays				1	**-0.941**	-0.040	**-0.617**
disordered Kaolinite					1	-0.045	**0.671**
Na-Smectite						1	-0.336
Ca-smectite							1

Table S5B: Correlation coefficients derived from elemental concentrations expressed as mass percentages (continued).

	Ferruginous smectite	Illite (1Md) + Dioct. Mica + Smectite	Illite (1M)	Biotite (1M)	Phlogopite (2M1)	Fe-Chlorite (Tusc)	Mg-Chlorite (Clinochlore)
Labradorite feldspar	-0.367	-0.414	-0.058	**0.616**	-0.203	0.022	-0.130
Calcite	**0.852**	**0.830**	**0.730**	0.201	-0.093	**0.758**	0.425
Dolomite	0.149	0.213	0.248	-0.270	-0.095	0.048	0.136
Hematite	0.107	0.007	0.242	-0.297	-0.057	-0.160	0.018
Goethite	**-0.499**	**-0.533**	-0.206	0.467	-0.048	-0.107	-0.325
Maghemite	**0.498**	**0.755**	0.185	0.041	-0.057	**0.637**	**0.486**
Apatite	**0.452**	**0.563**	0.177	-0.052	0.278	0.306	0.215
Quartz	**-0.954**	**-0.893**	**-0.761**	-0.127	0.062	**-0.731**	**-0.459**
Total non-clays	**-0.969**	**-0.892**	**-0.723**	-0.004	-0.020	**-0.655**	-0.415
disordered Kaolinite	**0.942**	**0.853**	**0.604**	-0.120	0.181	**0.500**	0.197
Na-Smectite	-0.121	0.122	-0.241	-0.253	0.376	0.022	0.104
Ca-smectite	**0.705**	0.359	**0.542**	0.138	-0.050	0.400	0.095
Ferruginous smectite	1	**0.850**	**0.709**	0.094	-0.012	**0.614**	0.367
Illite (1Md) + Dioct. Mica + Smectite		1	**0.475**	-0.110	0.030	**0.668**	0.430
Illite (1M)			1	0.377	-0.397	**0.635**	**0.493**
Biotite (1M)				1	**-0.636**	0.323	0.313
Phlogopite (2M1)					1	-0.301	**-0.648**
Fe-Chlorite (Tusc)						1	**0.475**
Mg-Chlorite (Clinochlore)							1

Table S5B: Correlation coefficients derived from elemental concentrations expressed as mass percentages (continued).

	Muscovite (2M1)	Total clays	total
Labradorite feldspar	**-0.440**	-0.355	**0.477**
Calcite	**0.868**	0.911	**-0.575**
Dolomite	0.281	0.185	-0.142
Hematite	0.122	0.045	-0.267
Goethite	**-0.520**	**-0.487**	**0.608**
Maghemite	**0.635**	**0.617**	-0.052
Apatite	**0.571**	**0.518**	-0.201
Quartz	**-0.949**	**-0.985**	**0.754**
Total non-clays	**-0.958**	**-0.984**	**0.828**
disordered Kaolinite	**0.954**	**0.932**	**-0.759**
Na-Smectite	-0.041	0.037	-0.042
Ca-smectite	0.547	**0.600**	**-0.535**
Ferruginous smectite	**0.954**	**0.964**	**-0.772**
Illite (1Md) + Dioct. Mica + Smectite	**0.926**	**0.931**	**-0.567**
Illite (1M)	**0.632**	**0.708**	**-0.611**
Biotite (1M)	-0.059	0.046	0.125
Phlogopite (2M1)	0.053	-0.038	-0.198
Fe-Chlorite (Tusc)	**0.594**	**0.719**	-0.309
Mg-Chlorite (Clinochlore)	**0.375**	**0.467**	-0.157

Table S5B: Correlation coefficients derived from elemental concentrations expressed as mass percentages (continued).

	Muscovite (2M1)	Total clays	total
Muscovite (2M1)	1	**0.968**	**-0.713**
Total clays		1	**-0.716**
Total			1

Table S5C: Correlation coefficients derived from elemental concentrations expressed as molar ratios[a].

	median	log (median)	mean	log (mean)	mode	log (mode)	organic C	total C	Mg	Al
median	1	**0.833**	**0.996**	**0.836**	**0.966**	**0.770**	**-0.683**	**-0.549**	**-0.786**	**-0.767**
log (median)		1	**0.823**	**0.988**	**0.830**	**0.956**	**-0.910**	**-0.743**	**-0.916**	**-0.947**
mean			1	**0.838**	**0.979**	**0.780**	**-0.672**	**-0.537**	**-0.763**	**-0.745**
log (mean)				1	**0.865**	**0.984**	**-0.887**	**-0.732**	**-0.883**	**-0.912**
mode					1	**0.832**	**-0.683**	**-0.548**	**-0.747**	**-0.717**
log (mode)						1	**-0.840**	**-0.716**	**-0.812**	**-0.851**
organic C							1	**0.727**	**0.852**	**0.858**
total C								1	**0.648**	**0.630**
Mg									1	**0.906**
Al										1

[a] Significant correlations (≥ 2σ from 0) are in bold text; highly significant correlations (≥ 4σ from 0) are in bold and red text.

Table S5C: Correlation coefficients derived from elemental concentrations expressed as molar ratios (continued).

	Si	P	S	Cl	K	Ca	Ti	V	Cr	Mn	Fe	Ni
median		**-0.665**	**-0.475**	**-0.350**	**-0.806**	**-0.641**	**-0.810**	**-0.665**	**-0.335**	**-0.726**	**-0.722**	**-0.772**
log (median)		**-0.902**	**-0.519**	**-0.295**	**-0.851**	**-0.835**	**-0.952**	**-0.947**	**-0.351**	**-0.921**	**-0.960**	**-0.962**
mean		**-0.652**	**-0.452**	**-0.315**	**-0.782**	**-0.615**	**-0.789**	**-0.655**	**-0.341**	**-0.705**	**-0.703**	**-0.750**
log (mean)		**-0.874**	**-0.482**	-0.245	**-0.819**	**-0.790**	**-0.922**	**-0.927**	**-0.361**	**-0.887**	**-0.928**	**-0.928**
mode		**-0.659**	**-0.395**	-0.214	**-0.734**	**-0.604**	**-0.769**	**-0.670**	**-0.329**	**-0.697**	**-0.694**	**-0.732**
log (mode)		**-0.823**	**-0.412**	-0.173	**-0.744**	**-0.715**	**-0.855**	**-0.899**	**-0.330**	**-0.817**	**-0.878**	**-0.871**
organic C		**0.916**	**0.531**	**0.275**	**0.701**	**0.824**	**0.867**	**0.890**	**0.293**	**0.918**	**0.907**	**0.908**
total C		**0.654**	**0.348**	0.166	**0.539**	**0.642**	**0.651**	**0.680**	**0.300**	**0.697**	**0.700**	**0.695**
Mg		**0.858**	**0.587**	0.302	**0.834**	**0.871**	**0.934**	**0.843**	0.190	**0.937**	**0.905**	**0.910**
Al		**0.844**	**0.604**	0.235	**0.928**	**0.729**	**0.984**	**0.911**	0.190	**0.926**	**0.974**	**0.971**
Si												
P		1	**0.554**	**0.288**	**0.674**	**0.872**	**0.846**	**0.889**	**0.242**	**0.888**	**0.866**	**0.848**
S			1	**0.509**	**0.648**	**0.621**	**0.627**	**0.477**	**0.308**	**0.559**	**0.573**	**0.586**
Cl				1	**0.295**	**0.425**	**0.273**	0.129	**0.525**	0.234	0.225	**0.241**
K					1	**0.624**	**0.931**	**0.734**	**0.260**	**0.810**	**0.875**	**0.890**
Ca						1	**0.781**	**0.727**	**0.291**	**0.856**	**0.769**	**0.755**
Ti							1	**0.889**	0.233	**0.944**	**0.968**	**0.966**
V								1	0.150	**0.907**	**0.952**	**0.924**
Cr									1	0.165	0.201	0.200
Mn										1	**0.953**	**0.940**
Fe											1	**0.983**
Ni												1

Table S5C: Correlation coefficients derived from elemental concentrations expressed as molar ratios (continued).

	Cu	Zn	Ga	As	Br	Rb	Sr	Y	Zr	Ba
median	**-0.316**	**-0.663**	**-0.716**	**-0.652**	**-0.645**	**-0.754**	**-0.617**	**-0.755**	**0.552**	**-0.486**
log (median)	**-0.668**	**-0.949**	**-0.961**	**-0.913**	**-0.881**	**-0.972**	**-0.884**	**-0.919**	**0.786**	**-0.634**
mean	**-0.278**	**-0.650**	**-0.699**	**-0.630**	**-0.630**	**-0.741**	**-0.602**	**-0.737**	**0.532**	**-0.478**
log (mean)	**-0.615**	**-0.924**	**-0.931**	**-0.871**	**-0.857**	**-0.947**	**-0.847**	**-0.896**	**0.741**	**-0.616**
mode	-0.281	**-0.662**	**-0.691**	**-0.612**	**-0.631**	**-0.736**	**-0.594**	**-0.747**	**0.518**	**-0.469**
log (mode)	**-0.575**	**-0.888**	**-0.887**	**-0.810**	**-0.807**	**-0.904**	**-0.790**	**-0.848**	**0.693**	**-0.546**
organic C	**0.575**	**0.929**	**0.896**	**0.885**	**0.886**	**0.908**	**0.898**	**0.834**	**-0.838**	**0.687**
total C	**0.444**	**0.677**	**0.651**	**0.705**	**0.608**	**0.695**	**0.666**	**0.602**	**-0.561**	**0.512**
Mg	**0.532**	**0.859**	**0.876**	**0.891**	**0.832**	**0.877**	**0.814**	**0.905**	**-0.630**	**0.489**
Al	**0.471**	**0.907**	**0.971**	**0.937**	**0.842**	**0.963**	**0.857**	**0.888**	**-0.674**	**0.584**
Si										
P	**0.387**	**0.894**	**0.861**	**0.849**	**0.822**	**0.878**	**0.929**	**0.858**	**-0.685**	**0.679**
S	**0.281**	**0.456**	**0.537**	**0.519**	**0.465**	**0.595**	**0.581**	**0.473**	**-0.374**	**0.557**
Cl	0.096	0.117	0.207	0.231	**0.248**	0.225	**0.270**	0.162	-0.085	**0.369**
K	**0.430**	**0.725**	**0.859**	**0.830**	**0.675**	**0.864**	**0.698**	**0.793**	**-0.527**	**0.542**
Ca	**0.459**	**0.748**	**0.722**	**0.760**	**0.694**	**0.756**	**0.871**	**0.770**	**-0.628**	**0.641**
Ti	**0.475**	**0.892**	**0.953**	**0.924**	**0.826**	**0.956**	**0.857**	**0.914**	**-0.657**	**0.603**
V	**0.465**	**0.976**	**0.950**	**0.927**	**0.881**	**0.953**	**0.899**	**0.855**	**-0.757**	**0.554**
Cr	0.021	0.094	0.159	0.171	0.142	0.227	0.219	0.091	-0.072	**0.459**
Mn	**0.513**	**0.928**	**0.927**	**0.939**	**0.875**	**0.925**	**0.912**	**0.897**	**-0.744**	**0.624**
Fe	**0.491**	**0.949**	**0.987**	**0.971**	**0.877**	**0.985**	**0.903**	**0.897**	**-0.742**	**0.591**
Ni	**0.496**	**0.925**	**0.970**	**0.958**	**0.872**	**0.964**	**0.864**	**0.892**	**-0.733**	**0.567**
Cu	1	**0.558**	**0.457**	**0.510**	**0.488**	**0.446**	**0.394**	**0.482**	**-0.306**	**0.281**
Zn		1	**0.945**	**0.932**	**0.895**	**0.944**	**0.900**	**0.874**	**-0.752**	**0.563**
Ga			1	**0.960**	**0.871**	**0.979**	**0.890**	**0.891**	**-0.740**	**0.572**

Table S5C: Correlation coefficients derived from elemental concentrations expressed as molar ratios (continued).

	La	Ce	Pb	Th	U	ordered Microcline feldspar	intermediate Microcline feldspar	Sanidine feldspar	Orthoclase feldspar
median	**-0.302**	**-0.452**	**-0.670**	**-0.749**	**-0.644**	**0.734**	**-0.556**	**-0.489**	**-0.598**
log (median)	**-0.380**	**-0.626**	**-0.924**	**-0.971**	**-0.885**	**0.819**	**-0.671**	-0.366	**-0.781**
mean	**-0.299**	**-0.446**	**-0.651**	**-0.734**	**-0.627**	**0.730**	**-0.551**	**-0.487**	**-0.598**
log (mean)	**-0.389**	**-0.627**	**-0.887**	**-0.948**	**-0.861**	**0.772**	**-0.616**	-0.386	**-0.772**
mode	**-0.315**	**-0.465**	**-0.639**	**-0.737**	**-0.620**	**0.704**	**-0.520**	**-0.492**	**-0.597**
log (mode)	**-0.375**	**-0.617**	**-0.834**	**-0.906**	**-0.829**	**0.698**	**-0.529**	-0.338	**-0.718**
organic C	**0.360**	**0.583**	**0.907**	**0.922**	**0.818**	**-0.868**	**0.761**	0.369	**0.755**
total C	0.265	**0.437**	**0.661**	**0.705**	**0.652**	**-0.847**	**0.729**	0.408	**0.715**
Mg	**0.374**	**0.543**	**0.854**	**0.888**	**0.829**	**-0.809**	**0.648**	**0.469**	**0.766**
Al	**0.385**	**0.612**	**0.936**	**0.950**	**0.879**	**-0.800**	**0.712**	0.321	**0.828**
Si									
P	**0.379**	**0.577**	**0.847**	**0.889**	**0.851**	**-0.765**	**0.774**	0.289	**0.817**
S	**0.291**	**0.414**	**0.539**	**0.513**	**0.619**	**-0.689**	**0.779**	0.215	**0.708**
Cl	**0.283**	**0.309**	0.165	0.159	**0.284**	**-0.521**	0.365	0.184	**0.560**
K	**0.419**	**0.587**	**0.831**	**0.811**	**0.771**	**-0.765**	**0.684**	0.412	**0.803**
Ca	**0.403**	**0.549**	**0.738**	**0.768**	**0.787**	**-0.768**	**0.700**	0.418	**0.704**
Ti	**0.402**	**0.639**	**0.918**	**0.949**	**0.883**	**-0.820**	**0.710**	0.397	**0.810**
V	**0.304**	**0.587**	**0.929**	**0.964**	**0.899**	**-0.812**	**0.722**	0.244	**0.849**
Cr	**0.360**	**0.431**	0.122	0.163	**0.243**	**-0.607**	**0.677**	0.101	**0.653**
Mn	**0.363**	**0.573**	**0.928**	**0.942**	**0.882**	**-0.833**	**0.784**	0.349	**0.811**
Fe	**0.374**	**0.636**	**0.955**	**0.976**	**0.905**	**-0.836**	**0.757**	0.280	**0.849**
Ni	**0.389**	**0.628**	**0.940**	**0.958**	**0.884**	**-0.845**	**0.751**	0.277	**0.810**
Cu	**0.410**	**0.444**	**0.607**	**0.442**	**0.459**	**-0.842**	**0.749**	0.303	**0.813**
Zn	**0.353**	**0.607**	**0.954**	**0.963**	**0.875**	**-0.835**	**0.780**	0.228	**0.844**
Ga	**0.333**	**0.601**	**0.941**	**0.972**	**0.893**	**-0.817**	**0.729**	0.230	**0.829**

Table S5C: Correlation coefficients derived from elemental concentrations expressed as molar ratios (continued).

	Albite feldspar (Cleavelandite)	Oligoclase feldspar	Labradorite feldspar	Calcite	Dolomite	Hematite	Goethite
median	**-0.519**	-0.250	0.392	**-0.791**	**-0.865**	**-0.591**	-0.174
log (median)	**-0.655**	**-0.501**	0.193	**-0.956**	**-0.924**	**-0.625**	-0.361
mean	**-0.509**	-0.251	0.397	**-0.790**	**-0.861**	**-0.594**	-0.174
log (mean)	**-0.616**	**-0.494**	0.185	**-0.941**	**-0.906**	**-0.644**	-0.355
mode	**-0.498**	-0.242	0.375	**-0.785**	**-0.850**	**-0.613**	-0.174
log (mode)	**-0.532**	**-0.443**	0.156	**-0.896**	**-0.830**	**-0.627**	-0.374
organic C	**0.723**	**0.471**	-0.195	**0.939**	**0.909**	**0.629**	0.310
total C	**0.883**	**0.539**	-0.064	**0.917**	**0.955**	**0.644**	0.302
Mg	**0.713**	**0.554**	-0.147	**0.935**	**0.984**	**0.622**	0.344
Al	**0.735**	**0.631**	-0.031	**0.981**	**0.921**	**0.595**	**0.444**
Si							
P	**0.828**	**0.652**	0.106	**0.939**	**0.878**	**0.480**	**0.499**
S	**0.778**	**0.537**	0.058	**0.883**	**0.800**	0.377	**0.548**
Cl	**0.504**	0.292	-0.396	**0.690**	**0.749**	**0.468**	0.031
K	**0.680**	**0.611**	-0.082	**0.945**	**0.929**	**0.681**	0.364
Ca	**0.819**	**0.578**	0.067	**0.869**	**0.924**	**0.511**	0.388
Ti	**0.755**	**0.585**	-0.072	**0.963**	**0.955**	**0.625**	0.374
V	**0.741**	**0.637**	0.019	**0.974**	**0.874**	**0.581**	**0.444**
Cr	**0.590**	**0.624**	0.032	**0.780**	**0.713**	**0.472**	0.341
Mn	**0.815**	**0.640**	0.024	**0.912**	**0.948**	**0.651**	0.279
Fe	**0.754**	**0.657**	-0.002	**0.982**	**0.933**	**0.667**	0.376
Ni	**0.760**	**0.559**	-0.057	**0.972**	**0.932**	**0.625**	0.361
Cu	**0.708**	**0.639**	-0.061	**0.968**	**0.944**	**0.673**	0.345
Zn	**0.777**	**0.647**	0.033	**0.976**	**0.903**	**0.621**	0.395
Ga	**0.705**	**0.638**	-0.007	**0.978**	**0.898**	**0.646**	0.409

Table S5C: Correlation coefficients derived from elemental concentrations expressed as molar ratios (continued).

	Maghemite	Apatite	Quartz	Total non-clays	disordered Kaolinite	Na-Smectite	Ca-smectite
median	**-0.553**	**-0.664**		**-0.722**	-0.288	**-0.455**	**-0.729**
log (median)	**-0.645**	**-0.812**		**-0.897**	-0.384	**-0.590**	**-0.899**
mean	**-0.546**	**-0.660**		**-0.727**	-0.282	**-0.465**	**-0.734**
log (mean)	**-0.622**	**-0.784**		**-0.900**	-0.344	**-0.623**	**-0.904**
mode	**-0.529**	**-0.636**		**-0.731**	-0.248	**-0.494**	**-0.742**
log (mode)	**-0.521**	**-0.712**		**-0.899**	-0.283	**-0.690**	**-0.892**
organic C	**0.583**	**0.738**		**0.791**	0.424	**0.561**	**0.841**
total C	**0.570**	**0.702**		**0.740**	0.309	**0.507**	**0.816**
Mg	**0.702**	**0.819**		**0.805**	0.365	**0.488**	**0.829**
Al	**0.678**	**0.838**		**0.892**	0.399	**0.597**	**0.901**
Si							
P	**0.634**	**0.782**		**0.784**	0.386	**0.534**	**0.806**
S	**0.522**	**0.707**		**0.712**	0.395	**0.570**	**0.730**
Cl	**0.673**	**0.621**		**0.557**	0.378	0.360	**0.602**
K	**0.683**	**0.823**		**0.863**	0.382	**0.506**	**0.880**
Ca	**0.622**	**0.727**		**0.665**	0.361	0.393	**0.702**
Ti	**0.686**	**0.819**		**0.849**	0.389	**0.524**	**0.868**
V	**0.648**	**0.815**		**0.903**	0.419	**0.586**	**0.910**
Cr	**0.482**	**0.658**		**0.677**	0.353	0.421	**0.685**
Mn	**0.676**	**0.742**		**0.715**	0.410	0.396	**0.777**
Fe	**0.678**	**0.819**		**0.878**	0.411	**0.566**	**0.909**
Ni	**0.641**	**0.785**		**0.861**	0.396	**0.596**	**0.883**
Cu	**0.683**	**0.830**		**0.866**	**0.427**	**0.544**	**0.900**
Zn	**0.644**	**0.788**		**0.863**	0.425	**0.570**	**0.891**
Ga	**0.643**	**0.812**		**0.911**	0.376	**0.651**	**0.932**

Table S5C: Correlation coefficients derived from elemental concentrations expressed as molar ratios (continued).

	Ferruginous smectite	Illite (1Md) + Dioct. Mica + Smectite	Illite (1M)	Biotite (1M)	Phlogopite (2M1)	Fe-Chlorite (Tusc)	Mg-Chlorite (Clinochlore)
median	**-0.734**	**-0.723**	-0.250	-0.318	**-0.736**	**-0.585**	**-0.754**
log (median)	**-0.878**	**-0.876**	-0.392	-0.425	**-0.883**	**-0.654**	**-0.913**
mean	**-0.734**	**-0.721**	-0.254	-0.331	**-0.739**	**-0.569**	**-0.754**
log (mean)	**-0.868**	**-0.859**	-0.395	**-0.469**	**-0.892**	**-0.577**	**-0.904**
mode	**-0.728**	**-0.722**	-0.260	-0.345	**-0.747**	**-0.530**	**-0.751**
log (mode)	**-0.817**	**-0.828**	-0.372	**-0.521**	**-0.860**	**-0.441**	**-0.867**
organic C	**0.788**	**0.862**	0.439	0.332	**0.853**	**0.761**	**0.820**
total C	**0.723**	**0.925**	**0.496**	0.185	**0.833**	**0.764**	**0.795**
Mg	**0.832**	**0.827**	0.422	0.351	**0.845**	**0.694**	**0.857**
Al	**0.881**	**0.888**	**0.472**	0.398	**0.907**	**0.685**	**0.914**
Si							
P	**0.795**	**0.850**	**0.525**	0.290	**0.885**	**0.707**	**0.814**
S	**0.689**	**0.782**	**0.469**	0.293	**0.827**	**0.621**	**0.717**
Cl	**0.660**	**0.444**	0.173	0.354	**0.543**	**0.526**	**0.611**
K	**0.871**	**0.877**	**0.451**	0.393	**0.865**	**0.682**	**0.905**
Ca	**0.716**	**0.772**	**0.485**	0.214	**0.777**	**0.712**	**0.723**
Ti	**0.869**	**0.871**	**0.462**	0.363	**0.885**	**0.707**	**0.887**
V	**0.888**	**0.898**	**0.486**	0.414	**0.907**	**0.668**	**0.916**
Cr	**0.680**	**0.684**	**0.432**	0.319	**0.663**	**0.518**	**0.683**
Mn	**0.795**	**0.844**	**0.530**	0.232	**0.869**	**0.791**	**0.792**
Fe	**0.882**	**0.914**	**0.524**	0.363	**0.907**	**0.739**	**0.914**
Ni	**0.862**	**0.888**	**0.477**	0.347	**0.899**	**0.717**	**0.882**
Cu	**0.871**	**0.908**	**0.498**	0.359	**0.887**	**0.763**	**0.914**
Zn	**0.870**	**0.908**	**0.521**	0.348	**0.917**	**0.726**	**0.889**
Ga	**0.878**	**0.915**	**0.510**	0.381	**0.905**	**0.695**	**0.927**

Table S5C: Correlation coefficients derived from elemental concentrations expressed as molar ratios (continued).

	Muscovite (2M1)	Total clays
median	**-0.781**	**-0.770**
log (median)	**-0.943**	**-0.941**
mean	**-0.779**	**-0.771**
log (mean)	**-0.925**	**-0.934**
mode	**-0.772**	**-0.771**
log (mode)	**-0.865**	**-0.904**
organic C	**0.935**	**0.878**
total C	**0.938**	**0.831**
Mg	**0.947**	**0.875**
Al	**0.979**	**0.947**
Si		
P	**0.952**	**0.863**
S	**0.882**	**0.783**
Cl	**0.688**	**0.626**
K	**0.953**	**0.922**
Ca	**0.898**	**0.760**
Ti	**0.970**	**0.917**
V	**0.967**	**0.954**
Cr	**0.782**	**0.723**
Mn	**0.941**	**0.833**
Fe	**0.985**	**0.950**
Ni	**0.967**	**0.929**
Cu	**0.971**	**0.941**
Zn	**0.975**	**0.938**
Ga	**0.970**	**0.964**

Table S5C: Correlation coefficients derived from elemental concentrations expressed as molar ratios (continued).

	As	Br	Rb	Sr	Y	Zr	Ba
As	1	**0.898**	**0.944**	**0.884**	**0.861**	**-0.755**	**0.573**
Br		1	**0.854**	**0.807**	**0.783**	**-0.705**	**0.497**
Rb			1	**0.913**	**0.879**	**-0.737**	**0.630**
Sr				1	**0.805**	**-0.768**	**0.752**
Y					1	**-0.577**	**0.473**
Zr						1	**-0.434**
Ba							1

Table S5C: Correlation coefficients derived from elemental concentrations expressed as molar ratios (continued).

	La	Ce	Pb	Th	U	ordered Microcline feldspar	intermediate Microcline feldspar	Sanidine feldspar	Orthoclase feldspar
As	**0.345**	**0.604**	**0.931**	**0.943**	**0.867**	**-0.797**	**0.755**	0.280	**0.861**
Br	0.210	**0.457**	**0.849**	**0.862**	**0.771**	**-0.762**	**0.674**	0.165	**0.841**
Rb	**0.385**	**0.648**	**0.944**	**0.977**	**0.907**	**-0.808**	**0.753**	0.270	**0.809**
Sr	**0.356**	**0.599**	**0.888**	**0.911**	**0.892**	**-0.780**	**0.819**	0.222	**0.827**
Y	**0.307**	**0.546**	**0.851**	**0.905**	**0.823**	**-0.786**	**0.700**	0.396	**0.759**
Zr	-0.165	**-0.397**	**-0.713**	**-0.751**	**-0.738**	**0.625**	**-0.617**	-0.296	**-0.618**
Ba	**0.529**	**0.625**	**0.646**	**0.576**	**0.637**	**-0.569**	**0.766**	0.135	**0.670**
La	1	**0.728**	**0.411**	**0.342**	**0.354**	**-0.616**	**0.584**	0.294	**0.640**
Ce		1	**0.632**	**0.635**	**0.610**	**-0.691**	**0.645**	0.255	**0.648**
Pb			1	**0.931**	**0.883**	**-0.809**	**0.802**	0.179	**0.856**
Th				1	**0.894**	**-0.800**	**0.725**	0.349	**0.809**
U					1	**-0.721**	**0.694**	0.330	**0.801**
ordered Microcline feldspar						1	**-0.730**	-0.083	**-0.729**
intermediate Microcline feldspar							1	-0.103	**0.650**
Sanidine feldspar								1	0.129
Orthoclase feldspar									1

Table S5C: Correlation coefficients derived from elemental concentrations expressed as molar ratios (continued).

	Albite feldspar (Cleavelandite)	Oligoclase feldspar	Labradorite feldspar	Calcite	Dolomite	Hematite	Goethite
As	**0.751**	**0.748**	0.040	**0.959**	**0.927**	**0.665**	0.384
Br	**0.709**	**0.589**	-0.170	**0.944**	**0.897**	**0.619**	0.242
Rb	**0.711**	**0.625**	-0.014	**0.981**	**0.913**	**0.651**	**0.440**
Sr	**0.854**	**0.722**	0.208	**0.928**	**0.865**	**0.560**	**0.434**
Y	**0.722**	**0.524**	-0.056	**0.905**	**0.920**	**0.623**	0.332
Zr	**-0.600**	-0.411	0.127	**-0.775**	**-0.732**	**-0.502**	-0.288
Ba	**0.825**	**0.719**	**0.548**	**0.652**	**0.621**	**0.482**	0.270
La	**0.724**	**0.470**	0.276	**0.685**	**0.690**	**0.558**	0.186
Ce	**0.575**	**0.567**	0.220	**0.756**	**0.739**	**0.700**	0.260
Pb	**0.797**	**0.700**	0.132	**0.937**	**0.860**	**0.614**	0.358
Th	**0.735**	**0.624**	-0.006	**0.977**	**0.934**	**0.631**	**0.448**
U	**0.787**	**0.584**	0.143	**0.886**	**0.793**	**0.483**	**0.447**
ordered Microcline feldspar	**-0.703**	-0.398	0.165	**-0.790**	**-0.795**	**-0.580**	0.015
intermediate Microcline feldspar	**0.755**	**0.561**	0.222	**0.690**	**0.636**	**0.493**	0.192
Sanidine feldspar	0.134	0.144	-0.119	0.265	**0.455**	0.204	0.352
Orthoclase feldspar	**0.737**	**0.741**	0.001	**0.850**	**0.747**	**0.543**	0.178
Albite feldspar (Cleavelandite)	1	**0.457**	0.215	**0.702**	**0.656**	0.256	0.162
Oligoclase feldspar		1	0.405	**0.639**	**0.558**	**0.533**	**0.431**

Table S5C: Correlation coefficients derived from elemental concentrations expressed as molar ratios (continued).

	Maghemite	Apatite	Quartz	Total non-clays	disordered Kaolinite	Na-Smectite	Ca-smectite
As	**0.717**	**0.836**		**0.828**	0.372	**0.543**	**0.886**
Br	**0.772**	**0.814**		**0.814**	**0.478**	**0.570**	**0.864**
Rb	**0.617**	**0.817**		**0.896**	0.421	**0.596**	**0.913**
Sr	**0.633**	**0.753**		**0.754**	0.410	**0.481**	**0.806**
Y	**0.601**	**0.751**		**0.796**	0.293	**0.513**	**0.824**
Zr	**-0.533**	**-0.622**		**-0.680**	-0.328	**-0.429**	**-0.696**
Ba	**0.458**	**0.444**		**0.429**	0.239	0.268	**0.527**
La	0.400	0.421		**0.570**	0.014	**0.471**	**0.642**
Ce	0.340	**0.497**		**0.704**	0.078	**0.623**	**0.762**
Pb	**0.653**	**0.760**		**0.807**	**0.480**	**0.467**	**0.836**
Th	**0.637**	**0.815**		**0.877**	0.373	**0.602**	**0.898**
U	**0.557**	**0.700**		**0.794**	0.306	**0.507**	**0.806**
ordered Microcline feldspar	**-0.536**	**-0.569**		**-0.675**	-0.314	**-0.449**	**-0.727**
intermediate Microcline feldspar	0.329	0.397		**0.452**	0.305	0.373	**0.556**
Sanidine feldspar	0.291	**0.432**		0.269	-0.149	0.004	0.253
Orthoclase feldspar	**0.825**	**0.742**		**0.755**	0.331	0.423	**0.820**
Albite feldspar (Cleavelandite)	**0.608**	**0.507**		**0.442**	0.334	0.221	**0.513**
Oligoclase feldspar	**0.518**	**0.594**		**0.546**	0.209	0.271	**0.621**

Table S5C: Correlation coefficients derived from elemental concentrations expressed as molar ratios (continued).

	Ferruginous smectite	Illite (1Md) + Dioct. Mica + Smectite	Illite (1M)	Biotite (1M)	Phlogopite (2M1)	Fe-Chlorite (Tusc)	Mg-Chlorite (Clinochlore)
As	**0.841**	**0.887**	**0.582**	0.310	**0.878**	**0.769**	**0.890**
Br	**0.867**	**0.779**	0.420	0.399	**0.872**	**0.742**	**0.862**
Rb	**0.861**	**0.930**	**0.492**	0.410	**0.891**	**0.690**	**0.913**
Sr	**0.785**	**0.867**	**0.602**	0.242	**0.863**	**0.763**	**0.804**
Y	**0.798**	**0.854**	**0.487**	0.288	**0.814**	**0.695**	**0.828**
Zr	**-0.697**	**-0.681**	-0.333	-0.319	**-0.707**	**-0.530**	**-0.713**
Ba	**0.519**	**0.664**	**0.702**	-0.083	**0.677**	**0.701**	**0.508**
La	**0.577**	**0.649**	**0.611**	0.085	**0.656**	**0.470**	**0.590**
Ce	**0.603**	**0.818**	**0.661**	0.199	**0.752**	**0.520**	**0.704**
Pb	**0.847**	**0.882**	**0.536**	0.304	**0.894**	**0.767**	**0.849**
Th	**0.850**	**0.910**	**0.499**	0.392	**0.904**	**0.674**	**0.900**
U	**0.792**	**0.814**	**0.548**	0.347	**0.847**	**0.563**	**0.796**
ordered Microcline feldspar	**-0.739**	**-0.755**	**-0.437**	-0.068	**-0.742**	**-0.805**	**-0.719**
intermediate Microcline feldspar	**0.502**	**0.761**	**0.666**	-0.155	**0.709**	**0.830**	**0.510**
Sanidine feldspar	0.217	0.233	0.085	0.300	0.162	-0.032	0.318
Orthoclase feldspar	**0.878**	**0.724**	**0.541**	0.256	**0.880**	**0.727**	**0.837**
Albite feldspar (Cleavelandite)	**0.638**	**0.543**	**0.526**	-0.047	**0.667**	**0.758**	**0.514**
Oligoclase feldspar	**0.552**	**0.689**	**0.604**	0.213	**0.695**	**0.468**	**0.633**

Table S5C: Correlation coefficients derived from elemental concentrations expressed as molar ratios (continued).

	Muscovite (2M1)	Total clays
As	**0.978**	**0.914**
Br	**0.943**	**0.902**
Rb	**0.974**	**0.952**
Sr	**0.950**	**0.854**
Y	**0.913**	**0.860**
Zr	**-0.771**	**-0.733**
Ba	**0.712**	**0.566**
La	**0.709**	**0.628**
Ce	**0.761**	**0.744**
Pb	**0.950**	**0.899**
Th	**0.977**	**0.935**
U	**0.891**	**0.843**
ordered Microcline feldspar	**-0.783**	**-0.770**
intermediate Microcline feldspar	**0.714**	**0.604**
Sanidine feldspar	0.304	0.225
Orthoclase feldspar	**0.878**	**0.852**
Albite feldspar (Cleavelandite)	**0.743**	**0.584**
Oligoclase feldspar	**0.693**	**0.624**

Table S5C: Correlation coefficients derived from elemental concentrations expressed as molar ratios (continued).

	Labradorite feldspar	Calcite	Dolomite	Hematite	Goethite
Labradorite feldspar	1	-0.088	-0.164	0.044	0.289
Calcite		1	**0.928**	**0.621**	**0.432**
Dolomite			1	**0.696**	0.321
Hematite				1	-0.007
Goethite					1

Table S5C: Correlation coefficients derived from elemental concentrations expressed as molar ratios (continued).

	Maghemite	Apatite	Quartz	Total non-clays	disordered Kaolinite	Na-Smectite	Ca-smectite
Labradorite feldspar	-0.286	-0.216		-0.176	-0.217	-0.011	-0.094
Calcite	**0.714**	**0.877**		**0.920**	**0.454**	**0.610**	**0.934**
Dolomite	**0.684**	**0.823**		**0.803**	0.372	**0.493**	**0.840**
Hematite	0.332	**0.443**		**0.616**	0.065	**0.486**	**0.729**
Goethite	0.065	**0.504**		**0.447**	0.114	0.375	**0.372**
Maghemite	1	**0.814**		**0.627**	**0.507**	0.156	**0.640**
Apatite		1		**0.864**	**0.538**	0.396	**0.825**
Quartz							
Total non-clays				1	0.346	**0.702**	**0.971**
disordered Kaolinite					1	-0.141	**0.253**
Na-Smectite						1	**0.737**
Ca-smectite							1

Table S5C: Correlation coefficients derived from elemental concentrations expressed as molar ratios (continued).

	Ferruginous smectite	Illite (1Md) + Dioct. Mica + Smectite	Illite (1M)	Biotite (1M)	Phlogopite (2M1)	Fe-Chlorite (Tusc)	Mg-Chlorite (Clinochlore)
Labradorite feldspar	-0.263	0.118	**0.539**	-0.280	-0.015	-0.033	-0.177
Calcite	**0.902**	**0.890**	**0.450**	**0.478**	**0.903**	**0.686**	**0.943**
Dolomite	**0.803**	**0.848**	**0.426**	0.385	**0.820**	**0.701**	**0.860**
Hematite	**0.510**	**0.776**	**0.570**	0.202	**0.584**	**0.519**	**0.667**
Goethite	0.192	**0.458**	0.204	**0.465**	0.312	-0.081	0.381
Maghemite	**0.862**	0.417	0.149	0.402	**0.680**	**0.633**	**0.743**
Apatite	**0.858**	**0.691**	0.191	**0.687**	**0.715**	**0.524**	**0.906**
Quartz							
Total non-clays	**0.879**	**0.834**	0.340	**0.634**	**0.795**	**0.465**	**0.976**
disordered Kaolinite	**0.535**	0.230	-0.322	**0.548**	**0.401**	0.411	0.374
Na-Smectite	0.411	**0.657**	**0.515**	0.229	**0.572**	0.269	**0.611**
Ca-smectite	**0.862**	**0.890**	**0.520**	**0.495**	**0.834**	**0.575**	**0.976**
Ferruginous smectite	1	**0.689**	0.232	**0.521**	**0.842**	**0.628**	**0.923**
Illite (1Md) + Dioct. Mica + Smectite		1	**0.640**	0.297	**0.830**	**0.642**	**0.849**
Illite (1M)			1	-0.302	**0.478**	**0.525**	0.390
Biotite (1M)				1	0.323	-0.126	**0.572**
Phlogopite (2M1)					1	**0.675**	**0.836**
Fe-Chlorite (Tusc)						1	**0.583**
Mg-Chlorite (Clinochlore)							1

Table S5C: Correlation coefficients derived from elemental concentrations expressed as molar ratios (continued).

	Muscovite (2M1)	Total clays
Labradorite feldspar	-0.033	-0.139
Calcite	**0.992**	**0.973**
Dolomite	**0.940**	**0.872**
Hematite	**0.632**	**0.667**
Goethite	0.422	0.370
Maghemite	**0.746**	**0.713**
Apatite	**0.877**	**0.873**
Quartz		
Total non-clays	**0.883**	**0.972**
disordered Kaolinite	**0.438**	0.424
Na-Smectite	**0.556**	**0.651**
Ca-smectite	**0.913**	**0.977**
Ferruginous smectite	**0.893**	**0.930**
Illite (1Md) + Dioct. Mica + Smectite	**0.886**	**0.880**
Illite (1M)	**0.499**	0.420
Biotite (1M)	**0.428**	**0.531**
Phlogopite (2M1)	**0.910**	**0.888**
Fe-Chlorite (Tusc)	**0.721**	**0.637**
Mg-Chlorite (Clinochlore)	**0.928**	**0.985**

Table S5C: Correlation coefficients derived from elemental concentrations expressed as molar ratios (continued).

	Muscovite (2M1)	Total clays
Muscovite (2M1)	1	**0.953**
Total clays		1
Total		

Figure S1

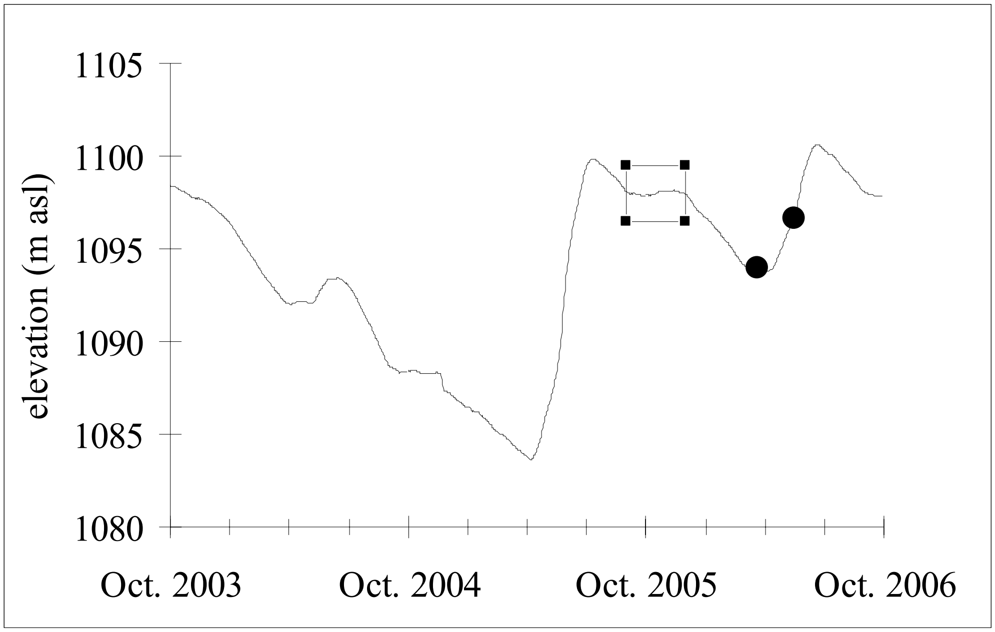

Figure S1: Water surface elevation of Lake Powell, hydrologic years 2004-2006. The square highlights three months of near-steady lake levels in advance of the lakebed sample collection, indicated by circles.

Figure S2

Figure S2: Layers of sediment at the 249.5 km delta shoreline location. The left panel shows sandy surface sediment underlain by a clay layer and another sandy layer. The right panel shows the same subsurface sandy layer as in the right panel underlain by another clay layer. Orange caps of core tubes are 5 cm in diameter.

Figure S3

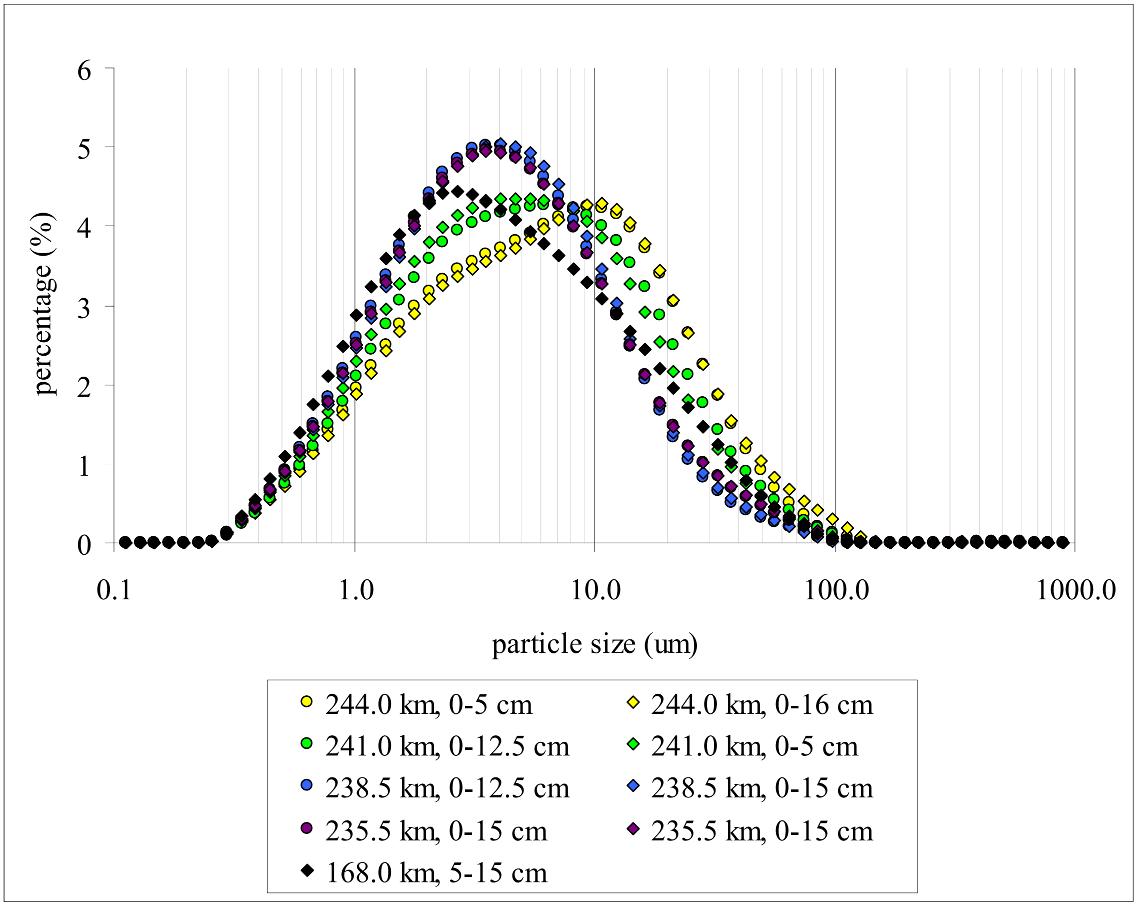

Figure S3: Particle size distributions of lakebed surface samples collected from delta sediment in March 2006.

Figure S4

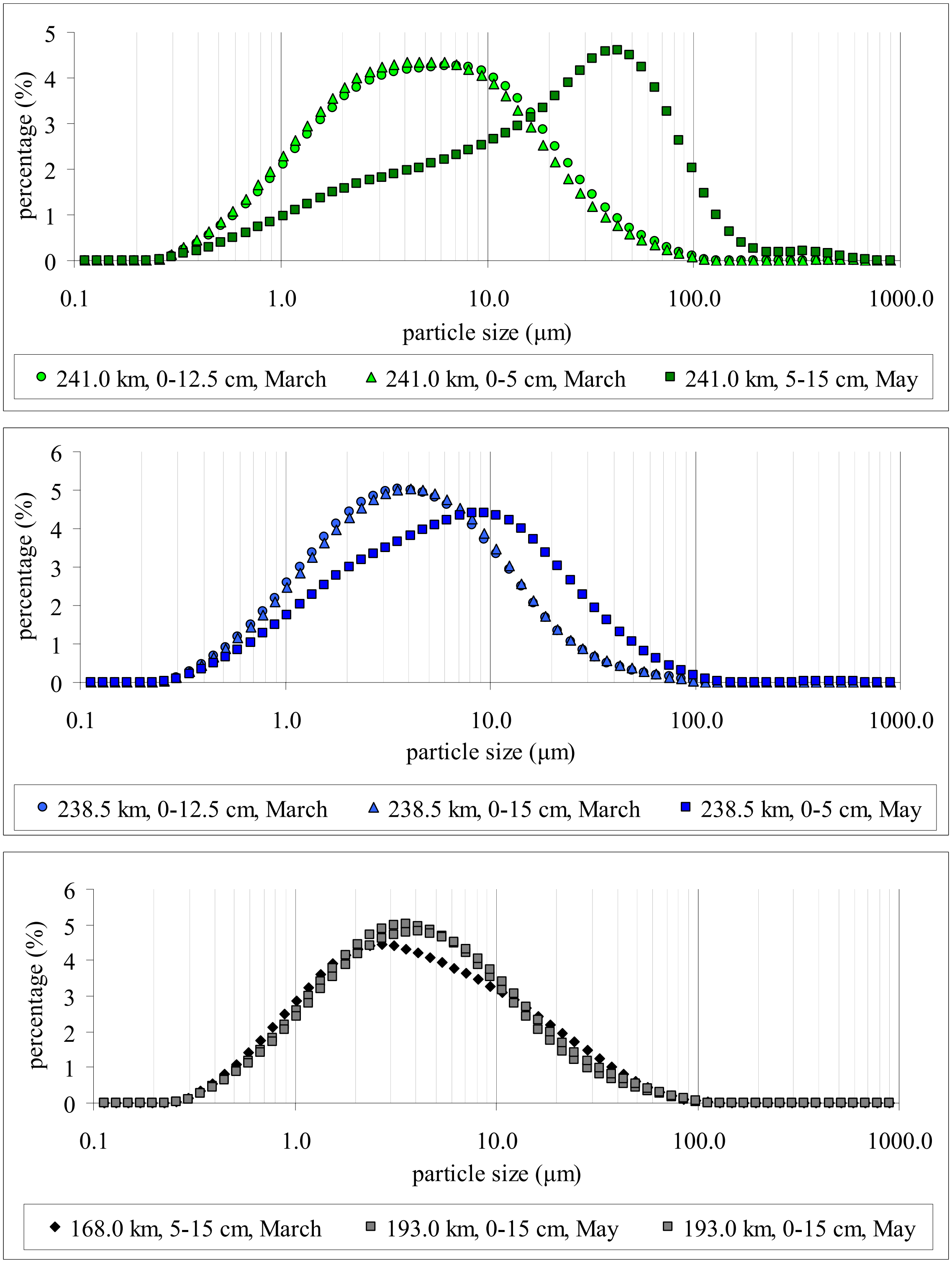

Figure S4: Particle size distributions of lakebed surface samples collected in March and May 2006. Upper panel: 241.0 km location; middle panel: 238.5 km location; lower panel: 168.0 and 178.0 km locations.

Figure S5

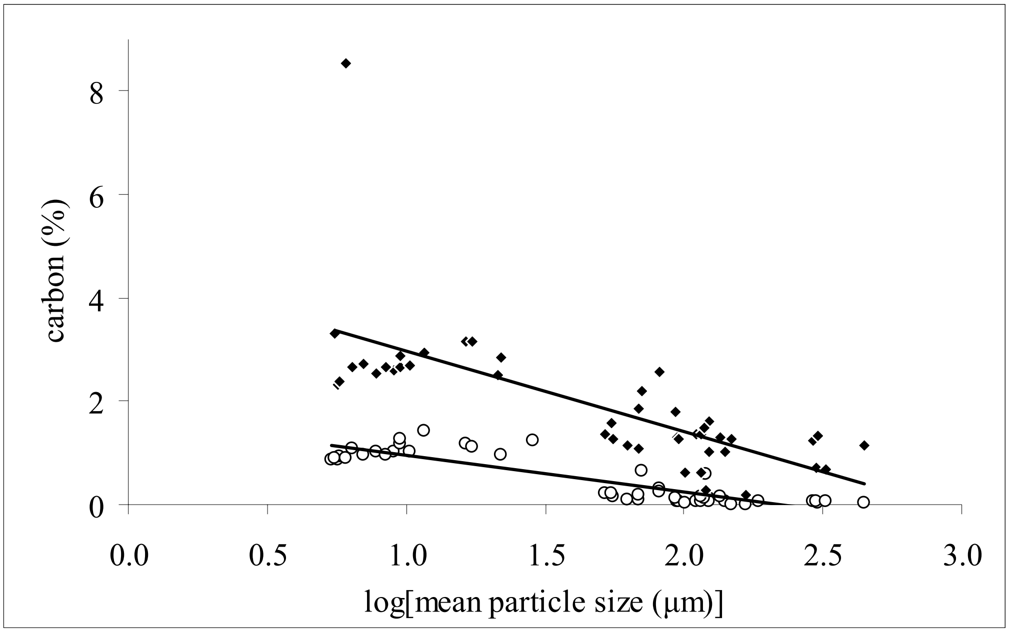

Figure S5: Total (♦) and organic (○) carbon in Lake Powell sediment. This graph does not include samples from cores TC A, TC B, or 247.5 C, in which plant debris were observed.

Figure S6

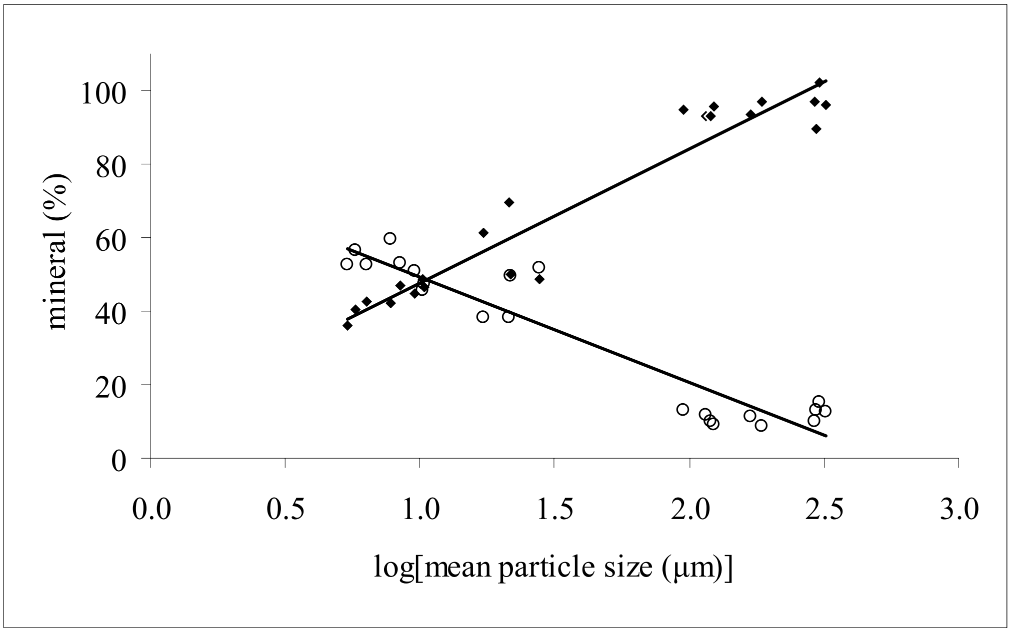

Figure S6: Concentrations of non-clay (♦) and clay (○) minerals in Lake Powell sediment.