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Corrigendum

Corrigendum to “Constraining the oceanic barium cycle with stable barium isotopes” [Earth Planet. Sci. Lett. 434 (2016) 1–9]

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After publication of our paper (Cao et al., 2016), we recently detected an unaccounted for matrix effect in the seawater Ba isotope measurements. Because our data were among the first seawater Ba isotope data published, the lack of other published data at that time did not allow us to compare our results and this analytical offset was only discovered when more seawater data became available in the literature.

We have now re-analyzed all seawater and river water samples published in Cao et al. (2016) on a Neptune MC-ICP-MS at GEOMAR, Kiel. Unfortunately, the suspended particle samples used for our original paper have been completely consumed. We therefore have analyzed filter samples collected from two additional depths in the upper 150 m at the same station A0. Note that we now present our data in the $\delta^{138/134}\text{Ba}$ notation relative to Ba standard NIST 3104a (Tables 1–3). The re-analyzed seawater data (Table 1) are consistent with published seawater $\delta^{138/134}\text{Ba}$ numbers and their range observed in the oceanic water column (Horner et al., 2015; Bates et al., 2017; Hsieh and Henderson, 2017; Bridgestock et al., 2018; Hemsing et al., 2018; Geyman et al., 2019). We also

analyzed the SAFE seawater reference material (GEOTRACES), and our data are indistinguishable within analytical uncertainty from the measurements by two other groups (Hsieh and Henderson, 2017; Geyman et al., 2019). Our re-analysis of river waters and filters are within error consistent with those reported in Cao et al. (2016), with an exception of the Changjiang River which is slightly heavier than the original measurement (Tables 2 and 3).

In this corrigendum we present all corrected data in Tables 1–3 and in Figs. 2–5 in accordance with those in Cao et al. (2016). We also point out that the variations and patterns of the data and correspondingly the interpretations and implications of our corrected results remain exactly the same as in our original paper. We acknowledge the invaluable effort and time that Yang Yu (GEOMAR, Kiel) invested into correcting the matrix problem and re-measuring all the samples including the SAFE samples and the new suspended particle samples. We would like to sincerely apologize for any inconvenience caused.

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Table 1

Salinity, dissolved barium (DBa) concentration and their stable barium isotopic composition ($\delta^{138/134}\text{Ba}_{\text{DBa}}$) data collected in the East China Sea (ECS) in August 2009 and in the South China Sea (SCS) in January 2010. Our new data for the SAFe seawater reference material (GEOTRACES) are included.

| Cruise | Station | Depth ^a (m) | Salinity ^a | DBa (nmol kg ⁻¹) | $\delta^{138/134}\text{Ba}_{\text{DBa}}$ (‰) | 2SD ^b (‰) | n ^c | |
|------------------------|---------------------------|---------------------------|-----------------------|---------------------------------|---|-------------------------|----------------|---|
| ECS August 2009 | PN10 31.0°N | 1.3 | 25.89 | 171.9 | 0.17 | 0.04 | 3 | |
| | | | | duplicate | 0.18 | 0.03 | 2 | |
| | 123.0°E | 4.5 | 27.17 | 157.9 | 0.23 | 0.06 | 5 | |
| | | 14.9 | 32.22 | 68.4 | 0.35 | 0.03 | 4 | |
| | | 25.1 | 34.00 | 50.0 | | | | |
| | | 35.5 | 34.11 | 48.9 | | | | |
| | | 46.9 | 34.13 | 49.6 | 0.43 | 0.05 | 4 | |
| | | PN04 29.0°N | 2.0 | 33.74 | 39.7 | 0.58 | 0.09 | 5 |
| | | 126.0°E | 24.4 | 33.83 | 39.5 | 0.57 | 0.07 | 4 |
| | | 49.4 | 33.85 | 38.0 | | | | |
| | | 73.8 | 34.10 | 37.6 | | | | |
| | | 99.8 | 34.50 | 38.8 | | | | |
| | DH13 29.0°N 127.3°E | 117.7 | 34.50 | 38.4 | 0.58 | 0.07 | 4 | |
| | | 3.2 | 33.73 | 35.8 | 0.61 | 0.10 | 4 | |
| | | 25.1 | 33.82 | 34.9 | 0.62 | 0.11 | 5 | |
| | | 49.6 | 33.99 | 36.4 | | | | |
| | | 73.8 | 34.18 | 38.9 | | | | |
| | | 98.6 | 34.39 | 38.9 | 0.63 | 0.10 | 5 | |
| | | 123.7 | 34.61 | 39.9 | 0.62 | 0.07 | 4 | |
| | | 148.6 | 34.49 | 43.4 | | | | |
| 198.5 | | 34.45 | 44.7 | 0.53 | 0.03 | 4 | | |
| 297.3 | | 34.37 | 50.8 | | | | | |
| 553.7 | 34.33 | 71.2 | 0.38 | 0.03 | 3 | | | |
| | | duplicate | 0.40 | 0.02 | 2 | | | |
| SCS January 2010 | KK1 18.3°N | 5.2 | 33.88 | 39.3 | 0.61 | 0.07 | 4 | |
| | | 19.6 | 33.88 | 37.5 | 0.59 | 0.04 | 3 | |
| | 115.7°E | | | duplicate | 0.62 | 0.00 | 3 | |
| | | 50.1 | 34.10 | 40.5 | 0.59 | 0.10 | 5 | |
| | | 79.8 | 34.49 | 39.5 | | | | |
| | | 98.3 | 34.57 | 39.7 | 0.59 | 0.07 | 5 | |
| | | 149.9 | 34.59 | 45.0 | | | | |
| | | 198.5 | 34.53 | 48.6 | 0.56 | 0.11 | 6 | |
| | | 301.0 | 34.44 | 54.6 | | | | |
| | | 499.2 | 34.41 | 73.8 | 0.42 | 0.09 | 5 | |
| | | 798.3 | 34.48 | 96.6 | 0.31 | 0.03 | 3 | |
| | | | | duplicate | 0.31 | 0.08 | 3 | |
| | | 1000.9 | 34.53 | 110.1 | 0.29 | 0.05 | 6 | |
| | | 1500.5 | 34.59 | 130.8 | 0.24 | 0.05 | 6 | |
| | | 2499.1 | 34.61 | 133.5 | 0.25 | 0.02 | 3 | |
| | | duplicate | 0.26 | 0.03 | 3 | | | |
| 3644.6 | 34.61 | 131.8 | 0.26 | 0.03 | 4 | | | |
| Pacific | SAFe | 2.0 | 34.75 | 34.1 | 0.64 | 0.08 | 5 | |
| | 30.0°N | 1000.0 | 34.41 | 99.3 | 0.29 | 0.02 | 4 | |
| | 140.0°W | | | duplicate | 0.32 | 0.05 | 5 | |

^a Depth and salinity data collected in the ECS are from Cao et al. (2015).

^b SD is the standard deviation estimated from the double spike bracketing measurements of a single sample solution.

^c n is the number of double spike bracketing measurements of a single sample solution.

Table 2

Excess particulate barium (Ba_{XS}) concentration and their stable barium isotopic composition ($\delta^{138/134}\text{Ba}_{\text{Baxs}}$) data collected in the upper 150 m of the water column at station A0 in the South China Sea (SCS).

| Cruise | Station | Depth (m) | Ba_{XS} (nmol kg ⁻¹) | $\delta^{138/134}\text{Ba}_{\text{Baxs}}$ (‰) | 2SD ^a (‰) | n ^b |
|-------------|----------------|--------------|---|--|-------------------------|----------------|
| SCS | A0 | 24.7 | 2.4 | 0.23 | 0.08 | 2 |
| August 2009 | 19.9°N 116.0°E | 124.1 | 1.0 | 0.19 | 0.02 | 2 |

^a SD is the standard deviation estimated from the double spike bracketing measurements of a single sample solution.

^b n is the number of double spike bracketing measurements of a single sample solution.

Table 3

Dissolved barium (DBa) concentration and their stable barium isotopic composition ($\delta^{138/134}\text{Ba}_{\text{DBa}}$) data collected in various global rivers.

| River | Location (°N, °E) | Sampling times | DBa (nmol kg ⁻¹) | $\delta^{138/134}\text{Ba}_{\text{DBa}}$ (‰) | 2SD ^a (‰) | n ^b |
|------------|----------------------|-------------------|---------------------------------|---|-------------------------|----------------|
| Changjiang | 31.8, 121.1 | 14 March 2015 | 419.6 | 0.19 | 0.01 | 3 |
| | | | duplicate | 0.19 | 0.06 | 4 |
| Amazon | 0.0, -51.0 | 13 November 2013 | 140.1 | 0.14 | 0.02 | 4 |
| Yukon | 65.9, -149.7 | 27 August 2009 | 1433.5 | 0.16 | 0.04 | 4 |
| Pearl | 23.0, 113.5 | 01 August 2012 | 204.5 | 0.19 | 0.08 | 4 |
| | | | duplicate | 0.15 | 0.04 | 3 |
| Sepik | -4.2, 143.8 | 08 June 2013 | 46.7 | 0.24 | 0.04 | 4 |
| Danube | 48.4, 10.0 | 31 August 2009 | 242.1 | 0.13 | 0.06 | 3 |
| Lena | 72.4, 126.7 | 20 August 2011 | 87.6 | 0.32 | 0.04 | 4 |
| Colorado | N.A. ^c | 06 November 2009 | 1025.1 | 0.30 | 0.03 | 4 |

^a SD is the standard deviation estimated from the double spike bracketing measurements of a single sample solution.

^b n is the number of double spike bracketing measurements of a single sample solution.

^c N.A. denotes data not available.

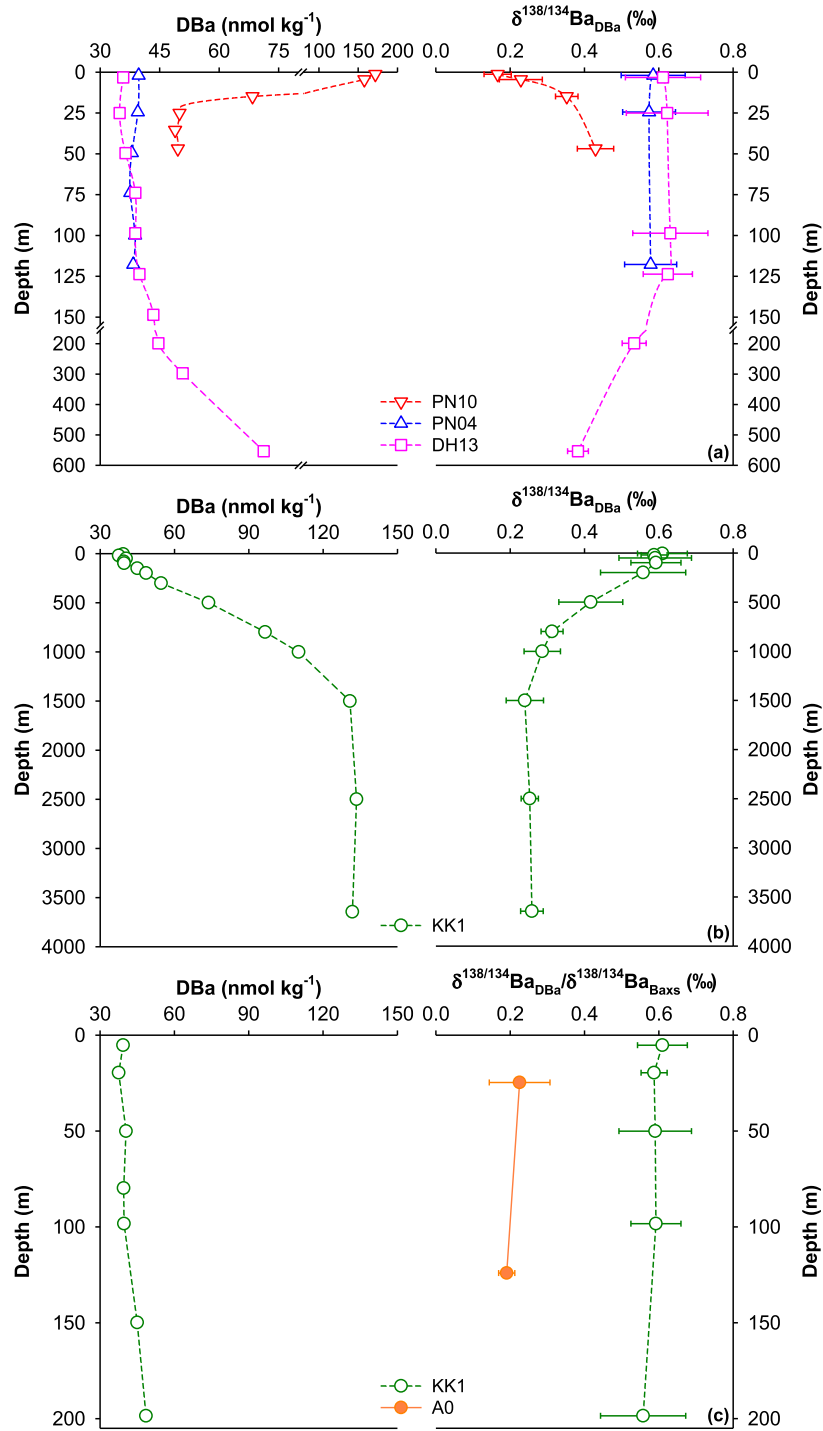


Fig. 2. Vertical distributions of dissolved barium (DBa) concentrations and their stable barium isotopic compositions ($\delta^{138/134}\text{Ba}_{\text{DBa}}$) in the East China Sea and the South China Sea. (a) Stations PN10, PN04, and DH13; (b) the entire water column at station KK1; (c) the upper 200 m at station KK1 (open circles) including the stable isotopic compositions of excess particulate barium ($\delta^{138/134}\text{Ba}_{\text{Baxs}}$) in the upper 150 m at station A0 (solid circles).

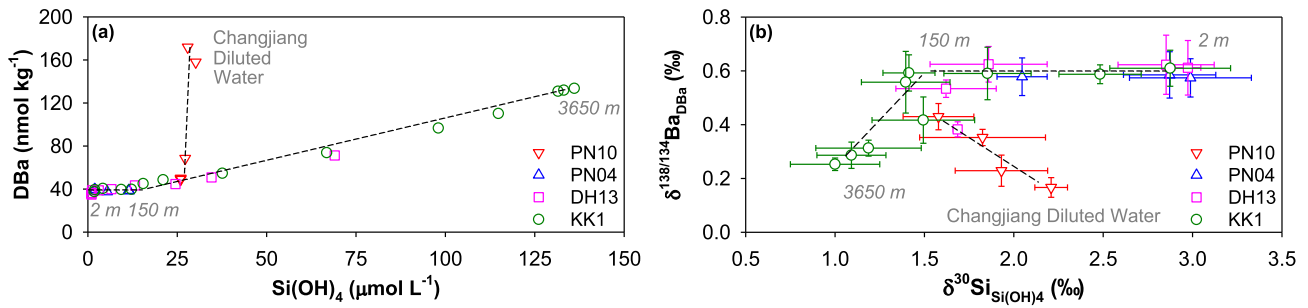


Fig. 3. (a) DBa versus Si(OH)_4 and (b) $\delta^{138/134}\text{Ba}_{\text{DBa}}$ versus $\delta^{30}\text{Si}_{\text{Si(OH)}_4}$ for samples collected in the East China Sea and the South China Sea. The dashed lines in each panel indicate trends of the DBa- Si(OH)_4 and the $\delta^{138/134}\text{Ba}_{\text{DBa}}$ - $\delta^{30}\text{Si}_{\text{Si(OH)}_4}$ relationships. The numbers in italics denote the sampling depth of the endpoints of each line excluding station PN10 influenced by the Changjiang Diluted Water. Si(OH)_4 and $\delta^{30}\text{Si}_{\text{Si(OH)}_4}$ data collected in the East China Sea are from Cao et al. (2015). $\delta^{138/134}\text{Ba}_{\text{DBa}}$ at station KK1 was compared to $\delta^{30}\text{Si}_{\text{Si(OH)}_4}$ at station SEATS (18.0°N, 116.0°E) occupied during the same cruise to the South China Sea (Cao et al., 2012) and located ~50 km southeast of station KK1.

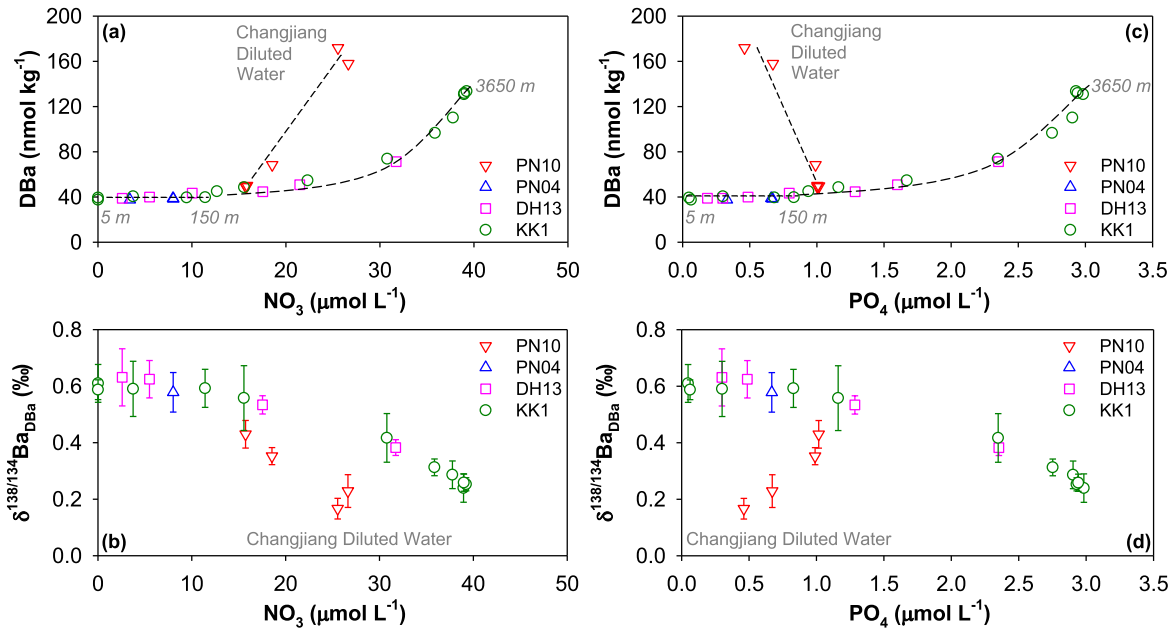


Fig. 4. Ba versus NO_3 and PO_4 for samples collected in the East China Sea and the South China Sea. (a) DBa versus NO_3 ; (b) $\delta^{138/134}\text{Ba}_{\text{DBa}}$ versus NO_3 ; (c) DBa versus PO_4 ; (d) $\delta^{138/134}\text{Ba}_{\text{DBa}}$ versus PO_4 . The dashed lines in (a) and (c) indicate trends of the DBa- NO_3 and the DBa- PO_4 relationships. The numbers in italics in (a) and (c) denote the sampling depth of the endpoints of each line excluding station PN10 influenced by the Changjiang Diluted Water. Note that concentrations of NO_3 and PO_4 in the upper 50–75 m at stations PN04 and DH13 were too low to be determined using classical colorimetric methods, while those in the surface mixed layer at station KK1 were measured by techniques targeting low-concentration nutrients at nM levels (Zhang, 2000; Ma et al., 2008). NO_3 and PO_4 data collected at station KK1 in the South China Sea are from Dai et al. (2013) and Du et al. (2013).

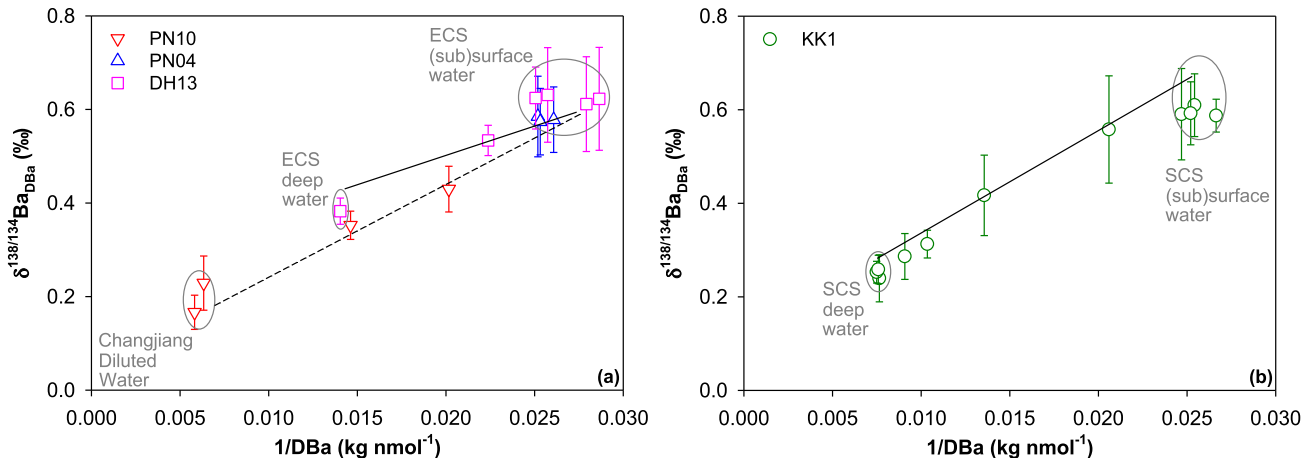


Fig. 5. $\delta^{138/134}\text{Ba}_{\text{DBa}}$ versus $1/\text{DBa}$ for samples collected in (a) the East China Sea (ECS) and (b) the South China Sea (SCS). In (a), the dashed line indicates the horizontal mixing between the Changjiang Diluted Water and the ECS surface water, while the solid line indicates the vertical mixing between the ECS (sub)surface water and the ECS deep water; in (b), the solid line indicates the vertical mixing between the SCS (sub)surface water and the SCS deep water.

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