

*Geochemistry, Geophysics, Geosystems*

Supporting Information for

**Incorporation of dissolved heavy metals into the skeleton of the scleractinian corals *Porites lobata* and *Porites lichen* based on multi-element culturing experiments**

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**Additional Supporting Information (Files uploaded separately)**

**Table S1:** TE/Ca values in the culturing medium of the control and the metal system. The mean values are given for both systems at the bottom of the table. Note that no Hg values are available for phase 0 of both systems. CL=Metal system, CR=Control system, W=week, D=Day, SE=Standard Error, Ph=Phase.

**Table S2:** Growth rates of the different coral colonies A, B, C and D in mm/ year. Calculations are based on the staining lines and the outer surface of the colonies after the experimental period. Staining took place before phase 0 (control phase) and before phase 1 (first metal phase). The system, the elemental scan line number and the growth rate in phase 0 and during phases 1 through 4 are indicated. (1) = polluted sites.

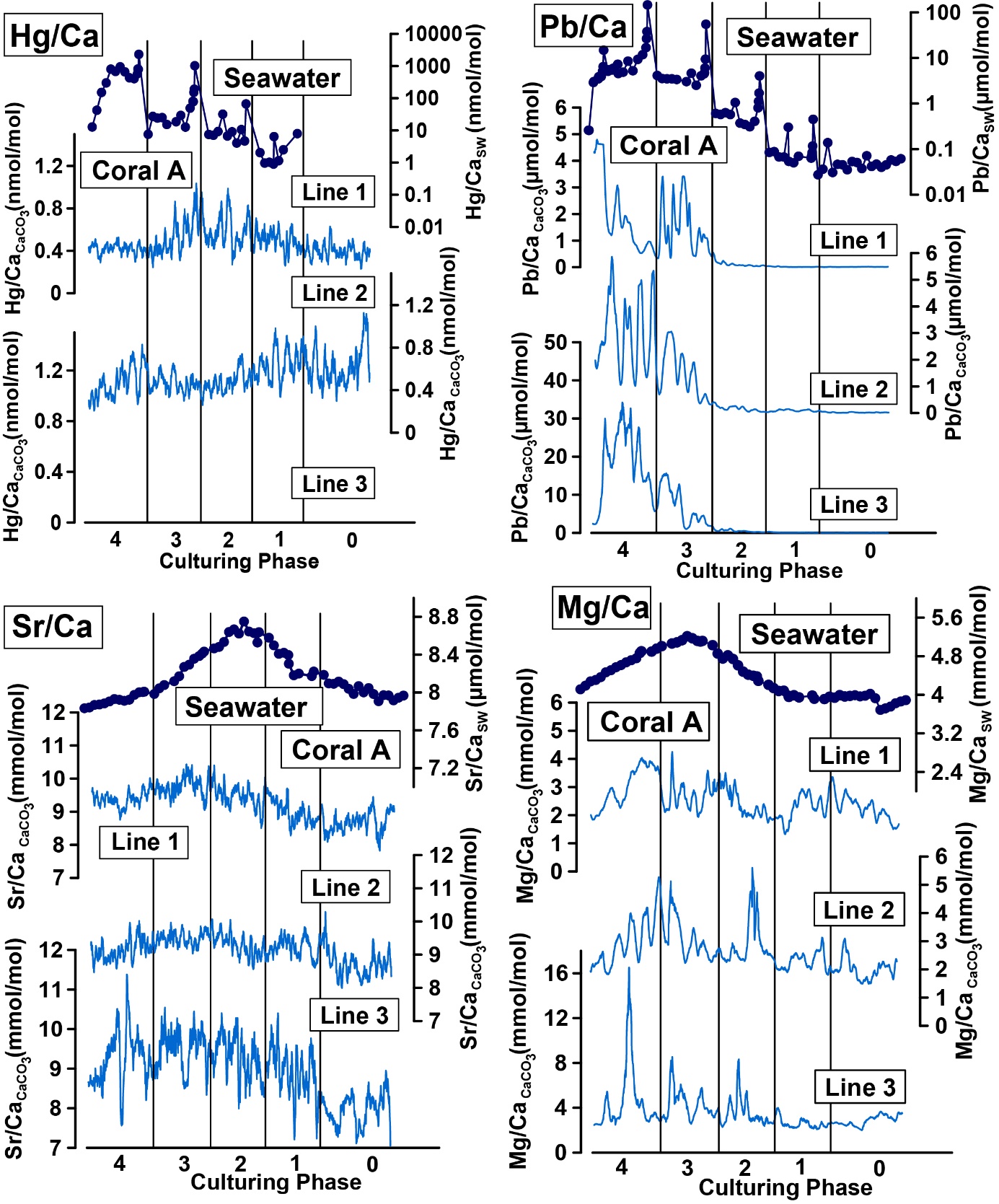
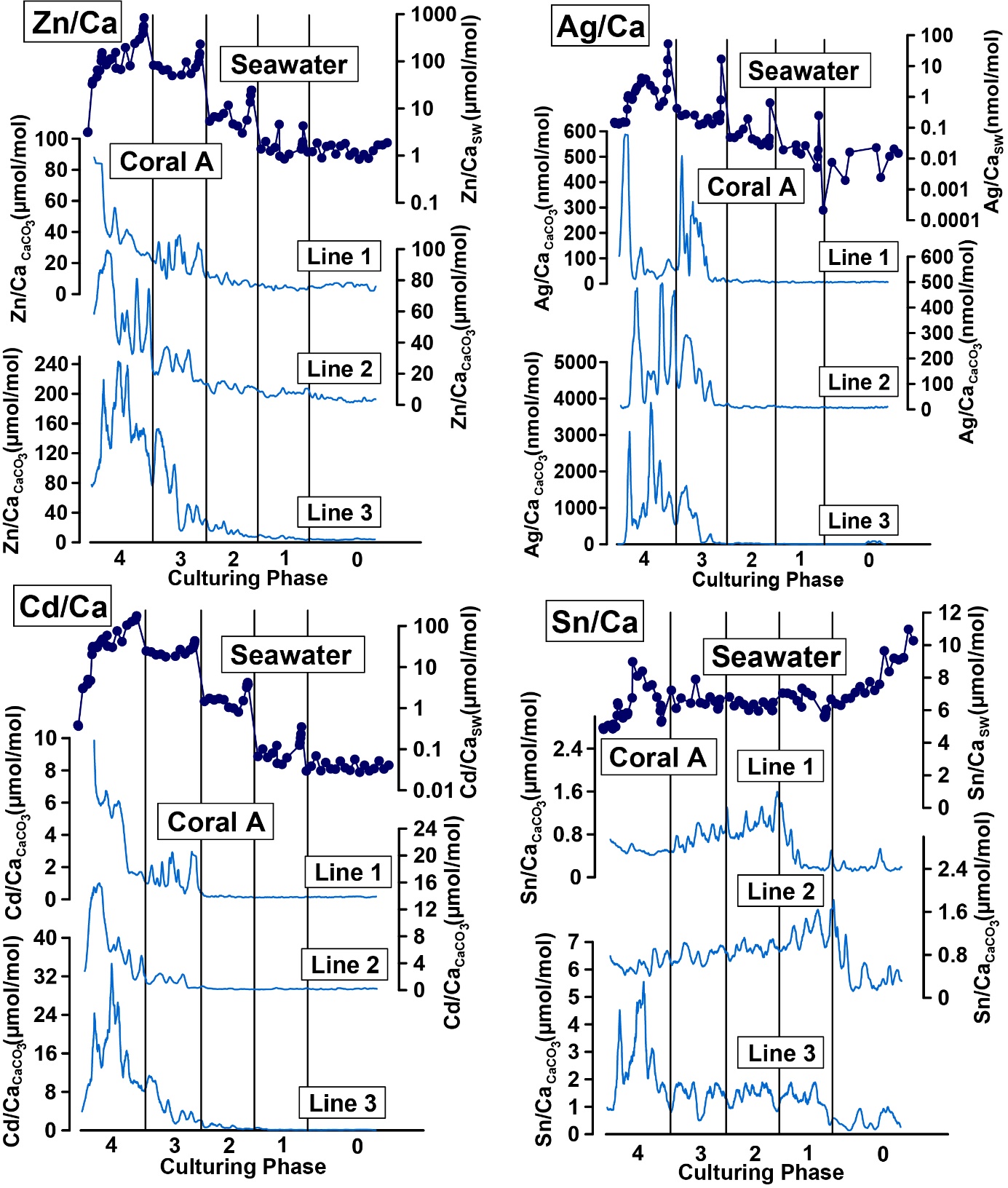
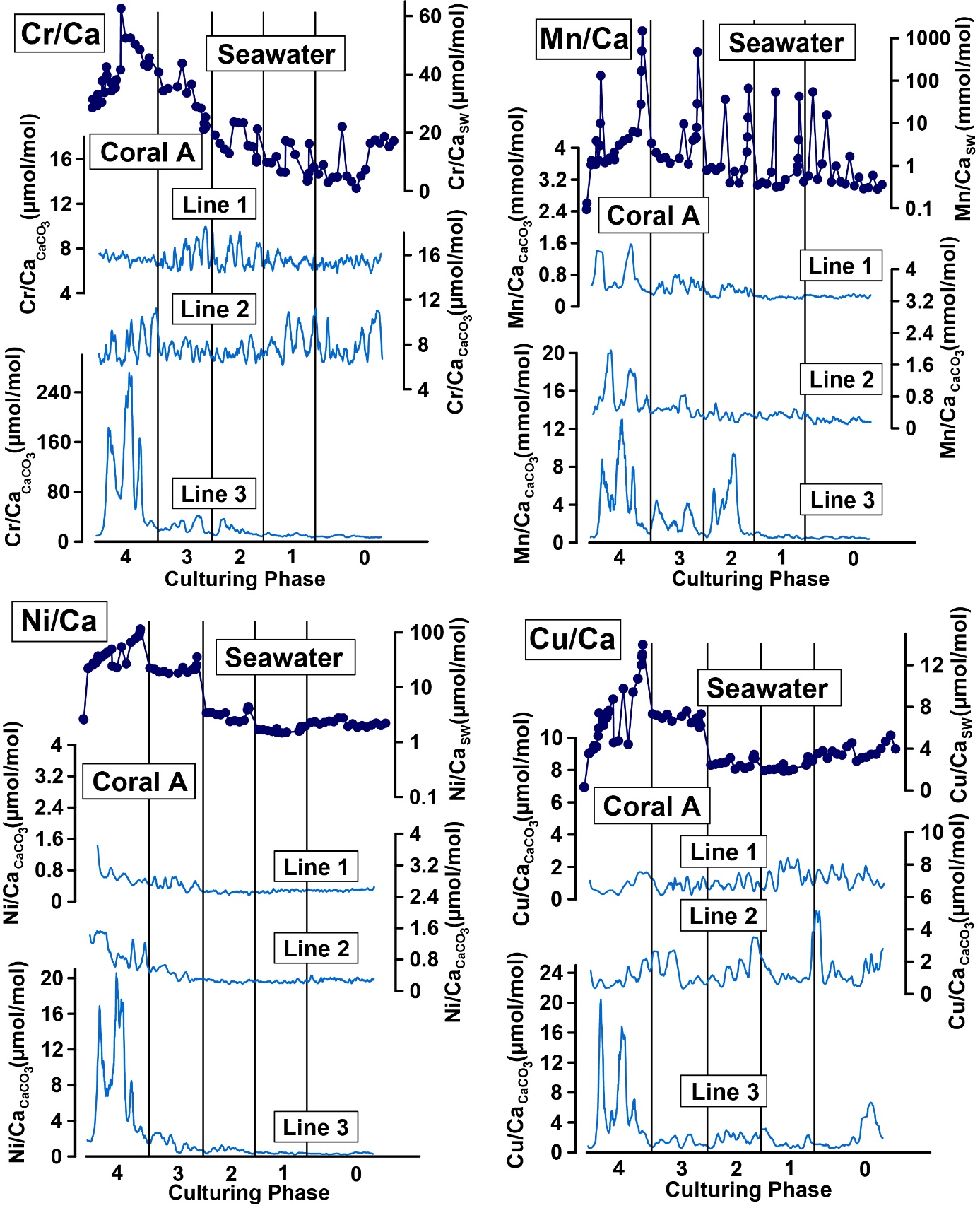
**Table S3:** Comparison of DTE values of the present study to other studies and other coral species. DTE values are derived from the composite line of all coral colonies. Sample preparation: 1 = NaClO + pre-ablation, 2 = H2O2 + HNO3, 3 = acid leaching/ oxidative/ reductive cleaning procedure after Shen and Boyle (1988), 4 = procedure Boyle et al., (1988) deionized water rinse, 5 = distilled water, HNO3, H2O2 + NaOH, H2NNH2 + NH4OH + C₆H₈O₇, coprecipitation with APDC + HNO3, 6 = dilution HCl, AgNO3 carrier for precipitating AgCl, HNO3, NH4OH, scavenging with ferric chloride, re-precipitation of silver with nitric acid, drying, dissolving in NH4OH.

**Introduction**

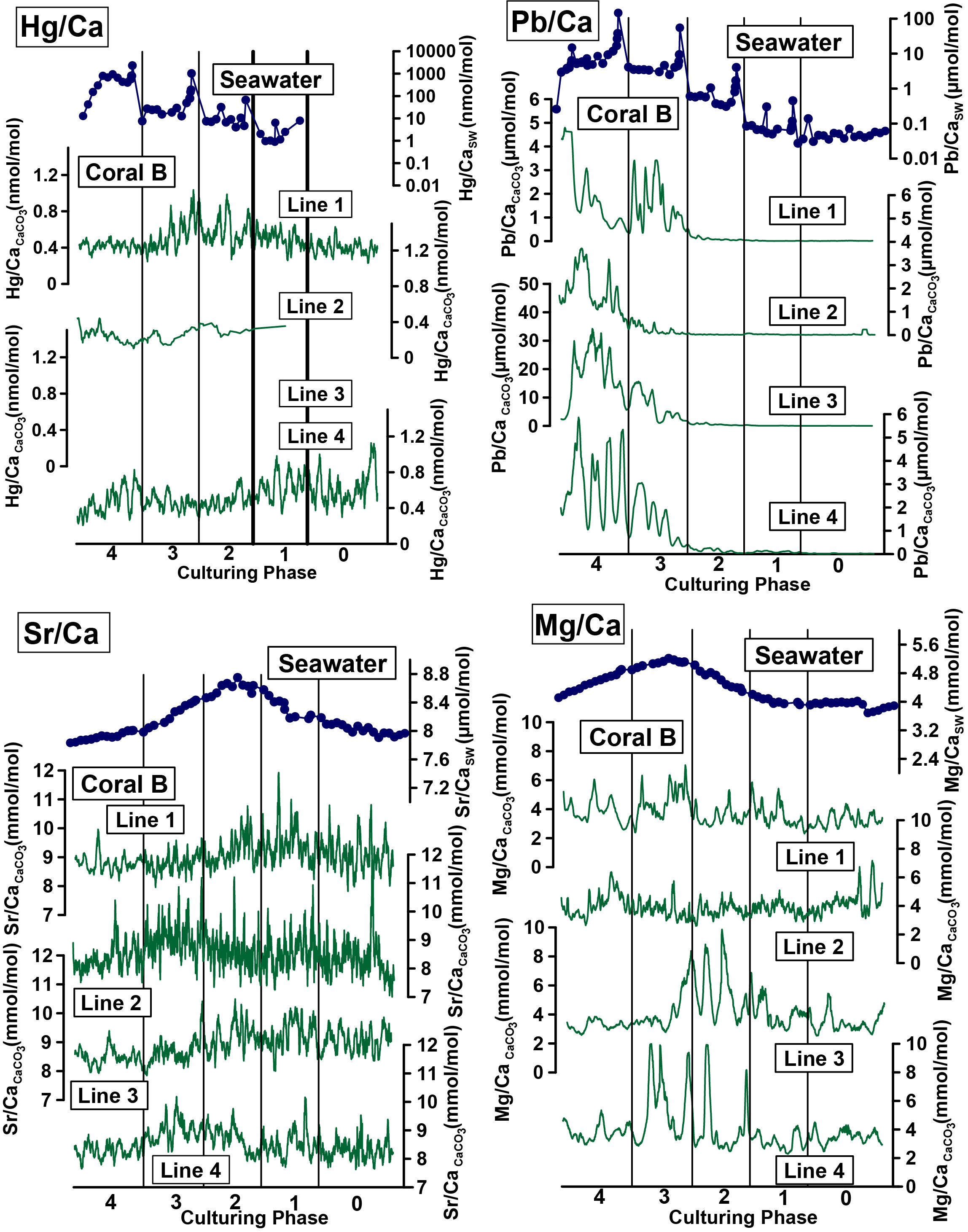
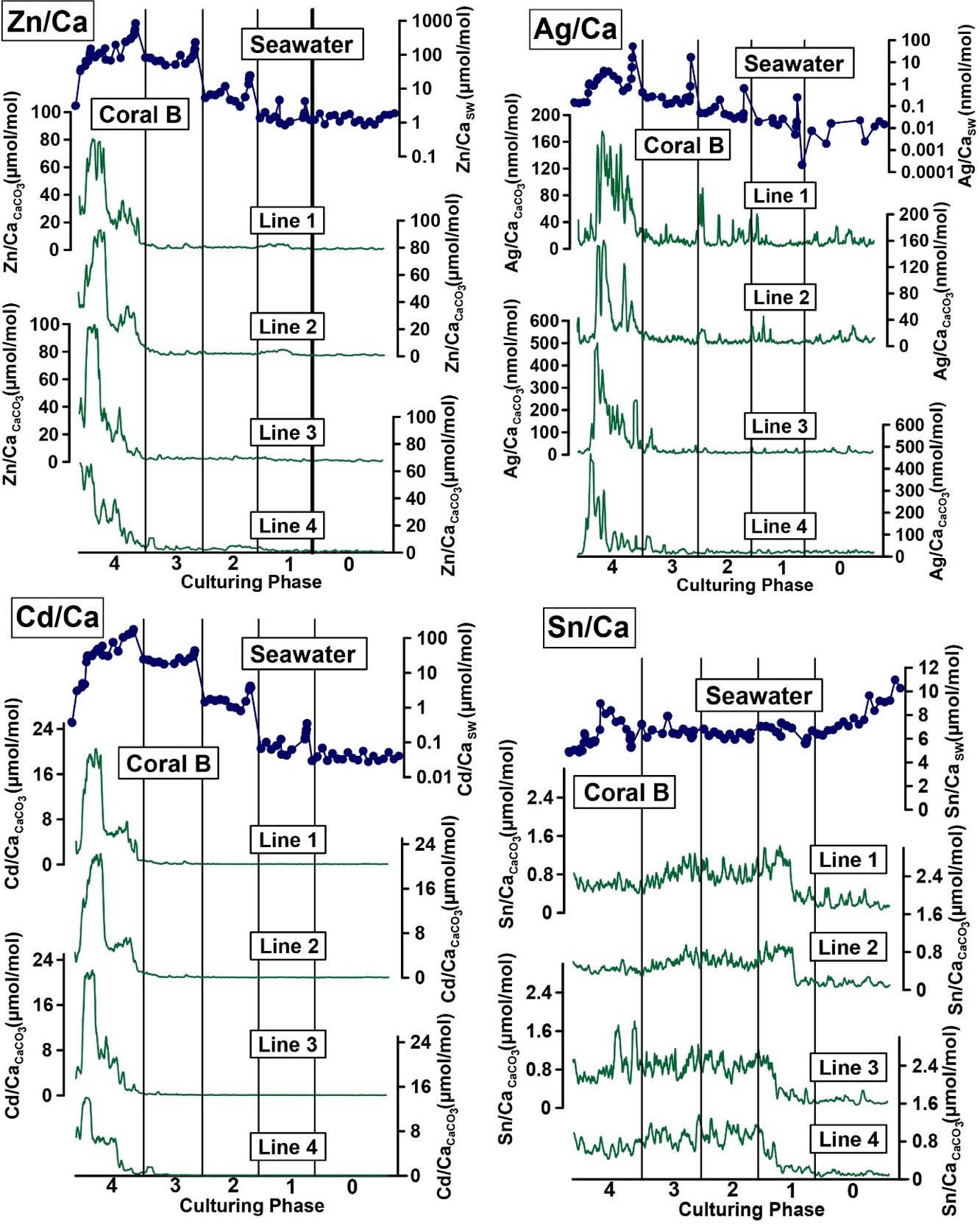
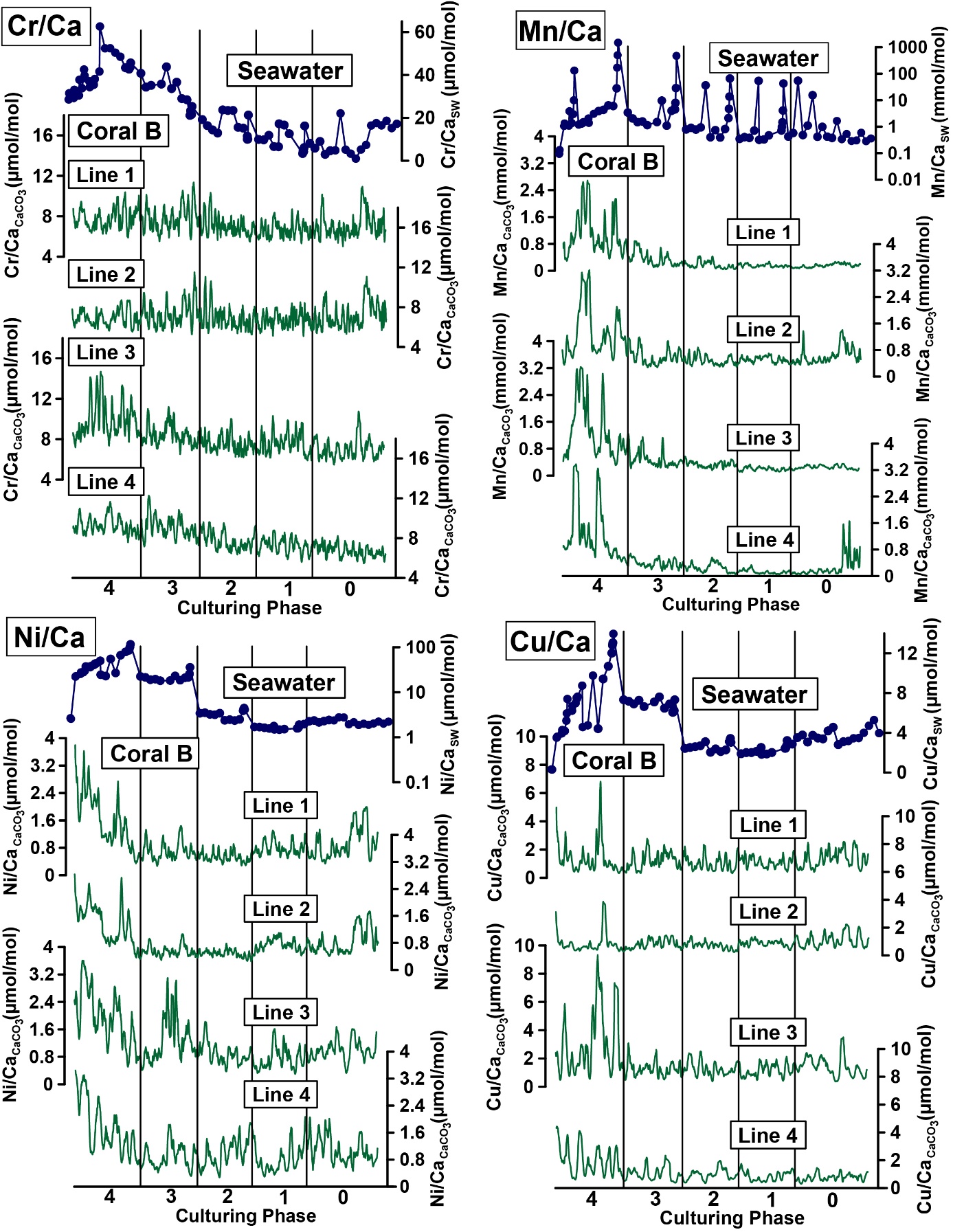
This supplement provides additional figures showing all individual laser ablation ICP-MS lines while composite lines are used in the main manuscript.

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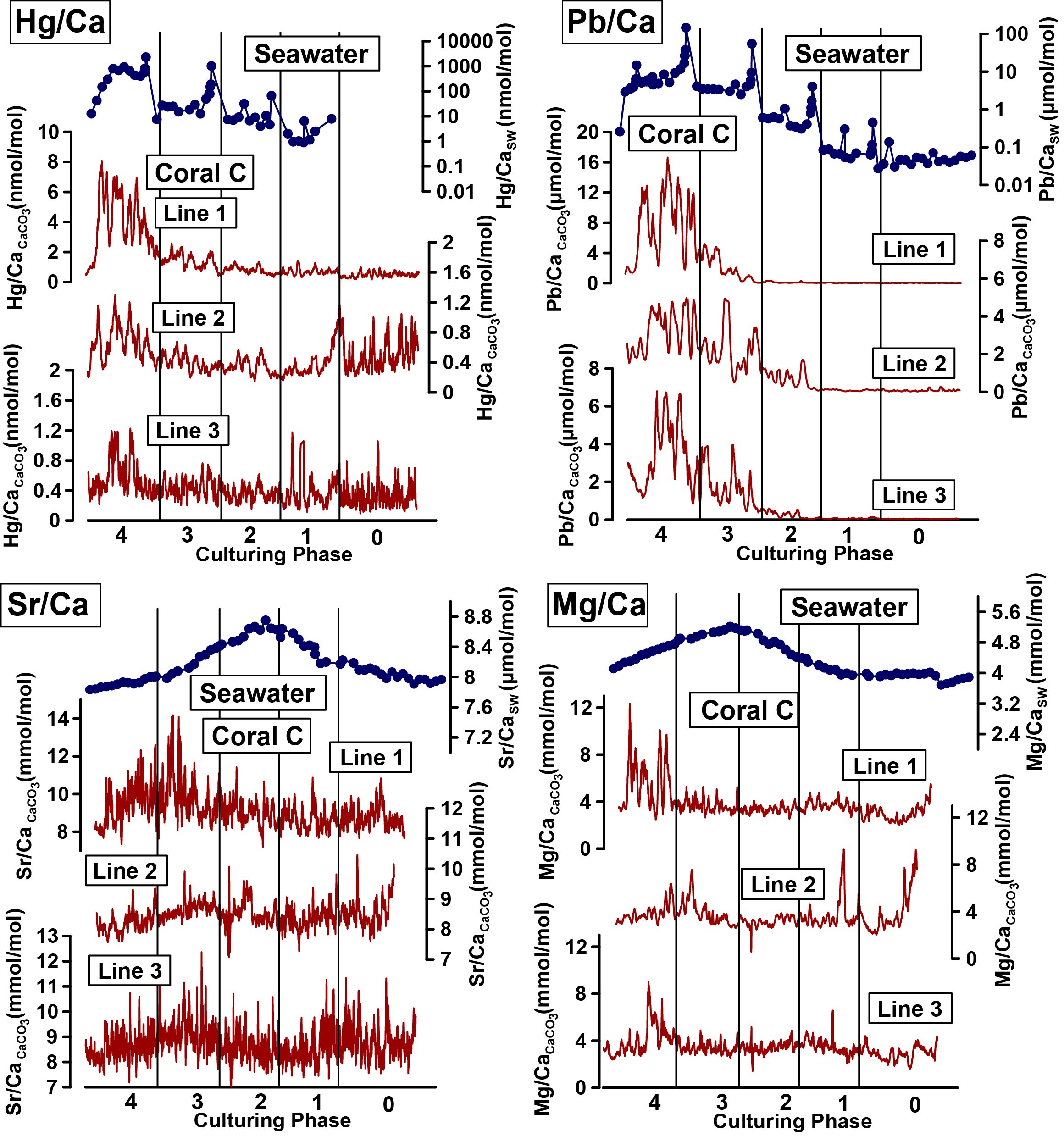
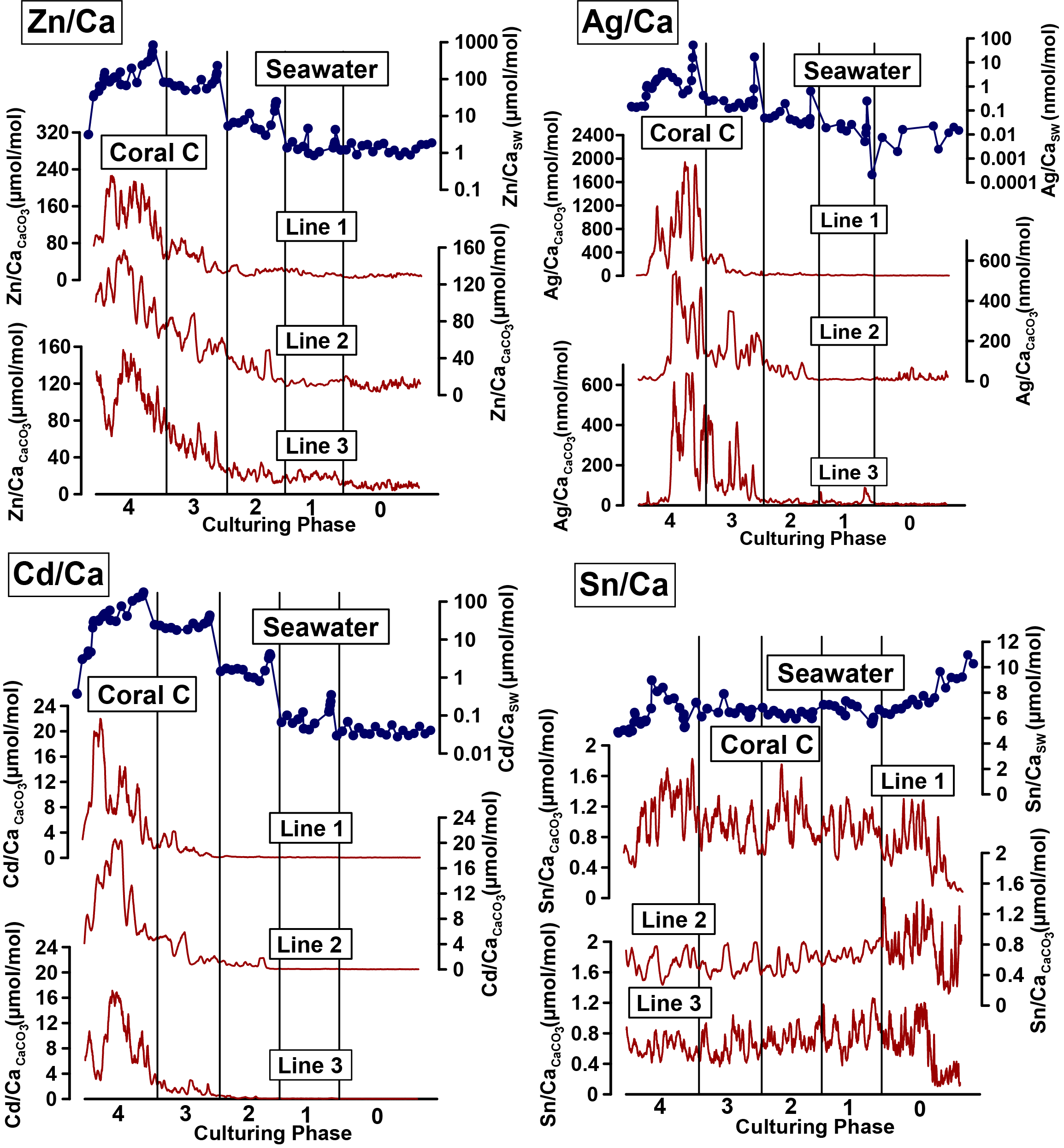
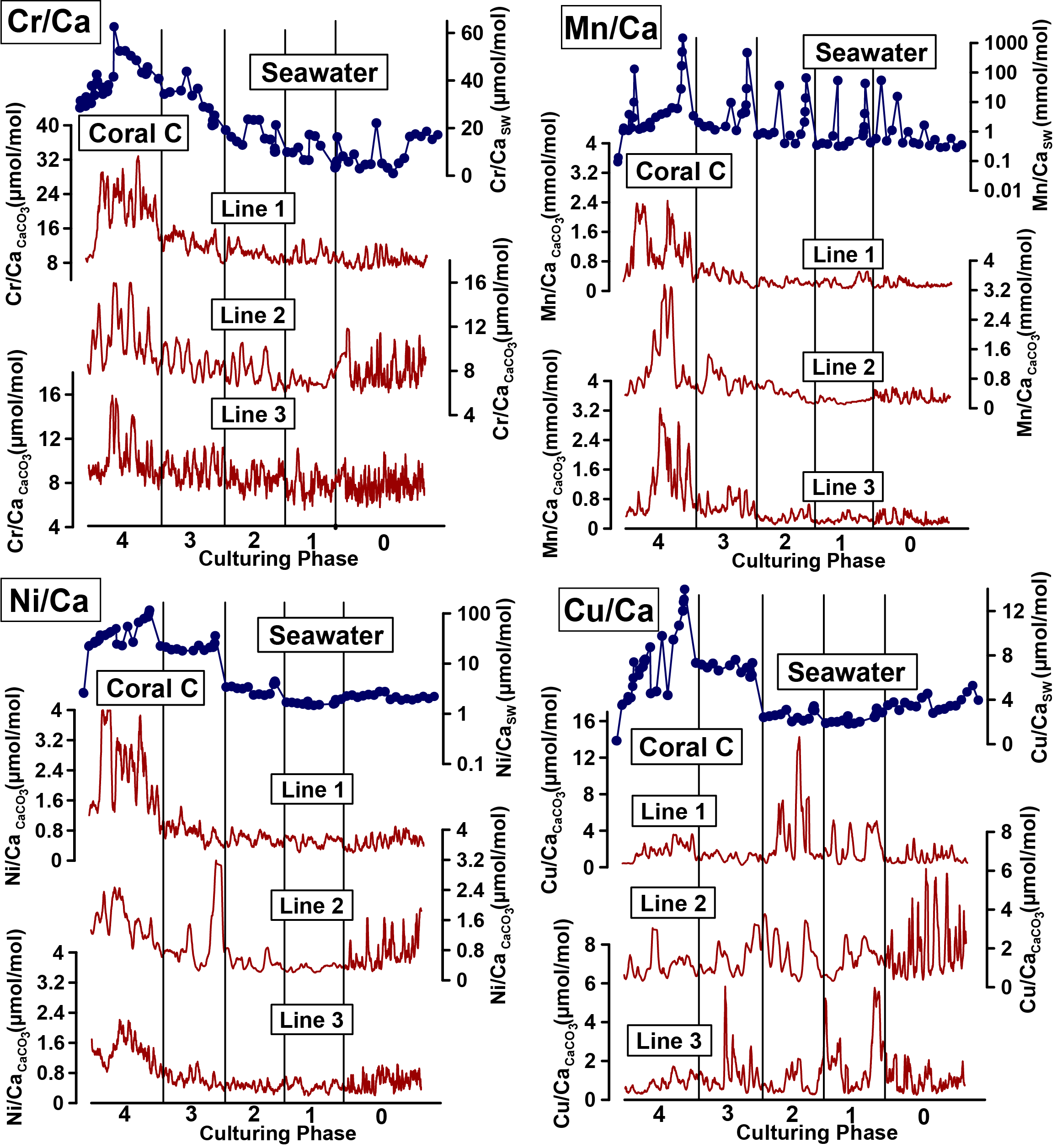
***Figure S1.*** Seawater Sn/Ca ratio measured in the metal and control systems over the experiment.

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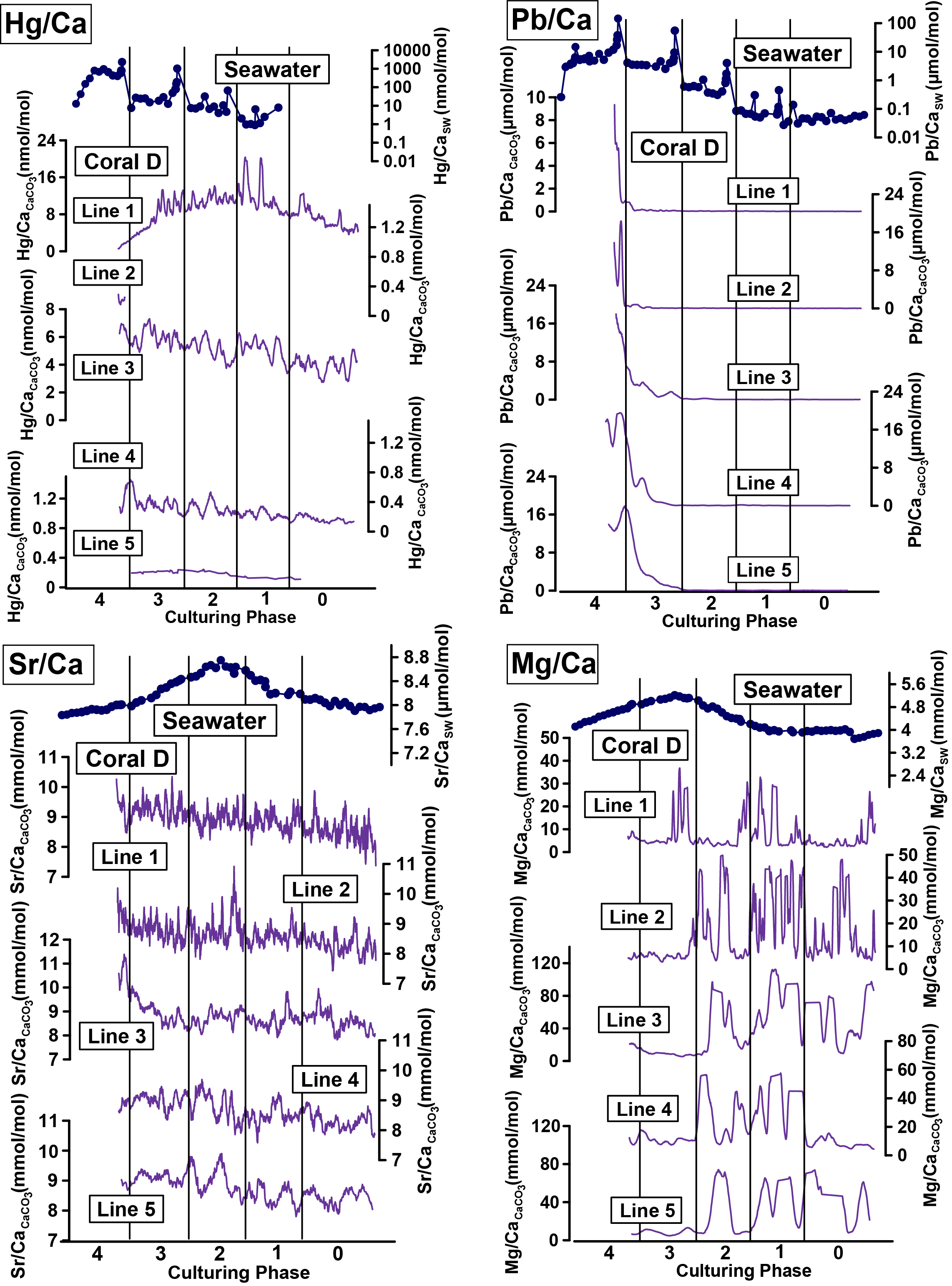
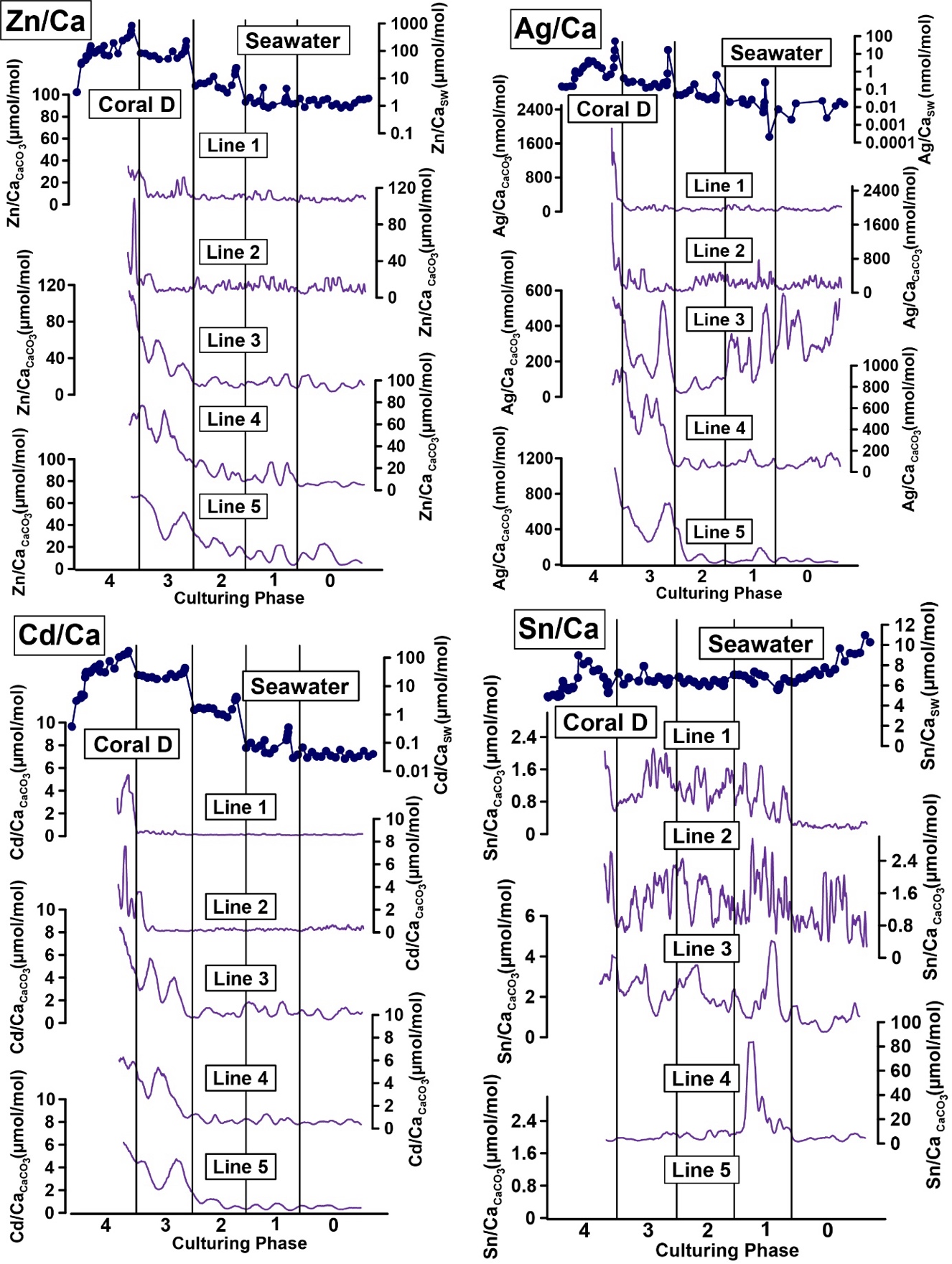
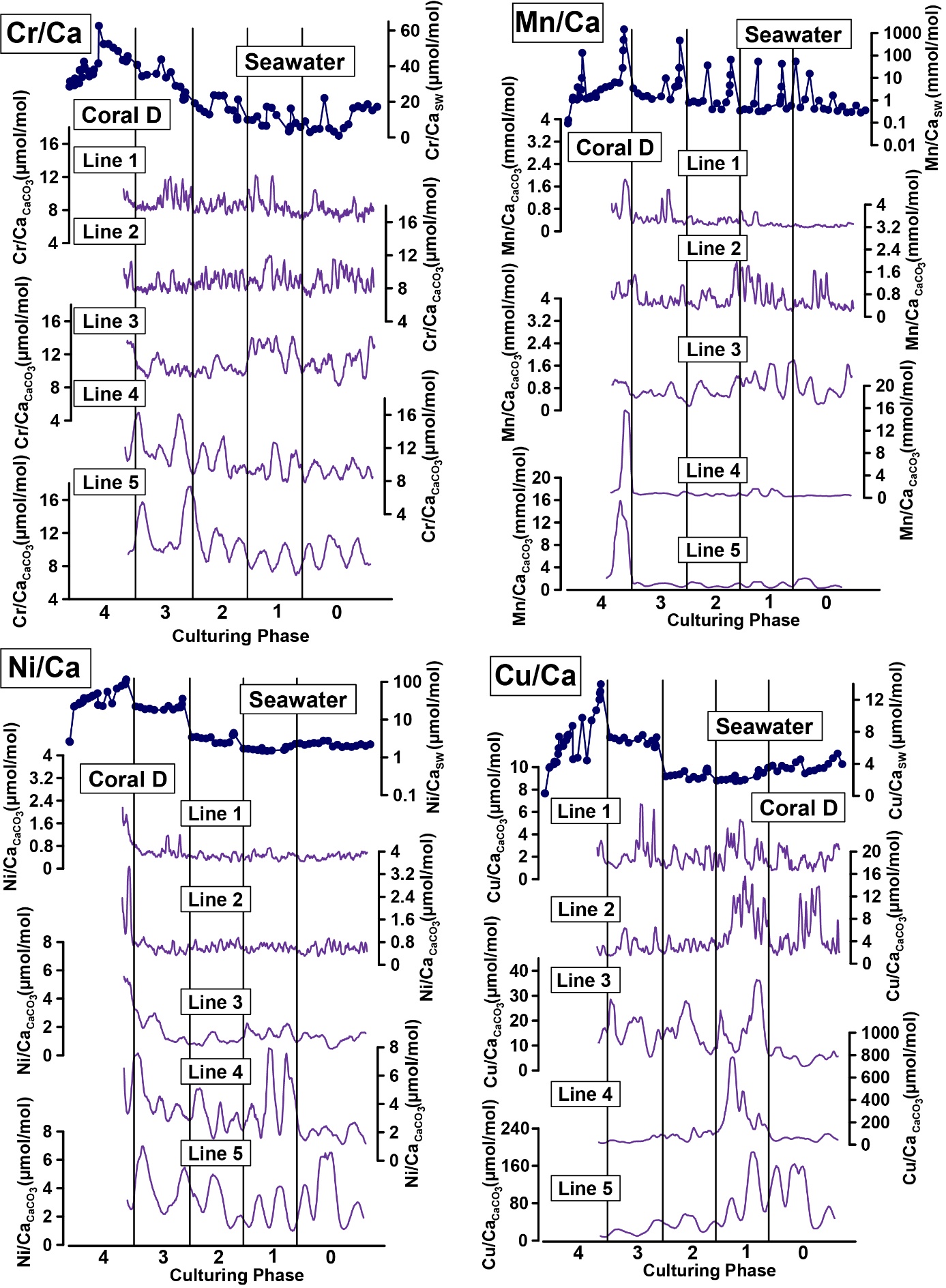
***Figure S2:*** *TE/Ca values of single lines on coral A cultured in the metal system measured by laser ablation ICP-MS and corresponding TE/Ca values in the culturing. To facilitate a comparison, all coral and water lines were transformed to the same Y-scale and therefore, differences in growth rates cannot be seen in this figure (see Table S2 for growth rates). Hg were not detectable in line 3. All elements but Cr, Cu, Sn, Sr and Mg are displayed with a logarithmic scale for the water measurements.*

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***Figure S3:*** *TE/Ca values of single lines on coral B cultured in the metal system measured by laser ablation ICP-MS and corresponding TE/Ca values in the culturing medium. To facilitate a comparison, all coral and water lines were transformed to the same Y-scale and therefore, differences in growth rates cannot be seen in this figure (see Table S2 for growth rates). Hg were not detectable in line 3. All elements but Cr, Cu, Sn, Sr and Mg are displayed with a logarithmic scale for the water measurements.*

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***Figure. S4:*** *TE/Ca values of single lines on coral C cultured in the metal system measured by laser ablation ICP-MS and corresponding TE/Ca values in the culturing medium. To facilitate a comparison, all coral and water lines were transformed to the same Y-scale and therefore, differences in growth rates cannot be seen in this figure (see Table 3 for growth rates). All elements but Cr, Cu, Sn, Sr and Mg are displayed with a logarithmic scale for the water measurements.*

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***Figure S5:*** *TE/Ca values of single lines on coral D cultured in the metal system measured by laser ablation ICP-MS and corresponding TE/Ca values in the culturing medium. To facilitate a comparison, all coral and water lines were transformed to the same Y-scale and therefore, differences in growth rates cannot be seen in this figure (see Table 3 for growth rates). Note that coral D died at the beginning of phase 4 after approximately 2.5 weeks. In some cases, Sn (line 5) and Hg (line 2, Phase 0 to 3) were not detectable. All elements but Cr, Cu, Sn, Sr and Mg are displayed with a logarithmic scale for the water measurements.*

***Table S4:*** *Mg/Ca and Sr/Ca values in the culturing medium of the metal system. CL=Metal system, W=week, D=Day, Ph=Phase.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Sample ID* | *Phase* | *Sampling  Date* | *Mg/Ca* | *Sr/Ca* |
| *Metal System* |  |  | *mmol/mol* | *µmol/mol* |
| *CL0 W2* | *0* | *16.8.19* | *3.89* | *7.97* |
| *CL0 W3* | *0* | *25.8.19* | *3.86* | *7.94* |
| *CL0 W4* | *0* | *29.8.19* | *3.83* | *7.92* |
| *CL0 W5* | *0* | *4.9.19* | *3.76* | *7.97* |
| *CL0 W6* | *0* | *9.9.19* | *3.72* | *7.97* |
| *CL0 W7* | *0* | *16.9.19* | *3.69* | *7.91* |
| *CL0 W8* | *0* | *23.9.19* | *3.93* | *7.98* |
| *CL0 W9* | *0* | *2.10.19* | *4.02* | *8.05* |
| *CL0 W10* | *0* | *7.10.19* | *3.98* | *8.00* |
| *CL0 W11* | *0* | *15.10.19* | *3.97* | *8.07* |
| *CL0 W12* | *0* | *21.10.19* | *3.99* | *7.98* |
| *CL0 W13* | *0* | *28.10.19* | *3.98* | *8.04* |
| *CL0 W14* | *0* | *4.11.19* | *3.96* | *8.09* |
| *CL0 W15* | *0* | *11.11.19* | *3.99* | *8.12* |
| *CL0 W16* | *0* | *21.11.19* | *3.94* | *8.09* |
| *CL0 W17* | *0* | *28.11.19* | *3.96* | *8.10* |
| *CL0 W18* | *0* | *5.12.19* | *3.91* | *8.19* |
| *CL0 W19* | *0* | *10.12.19* | *3.92* | *8.22* |
| *CL1 W1 D1* | *1* | *16.12.19* | *3.98* | *8.17* |
| *CL1 W1 D5* | *1* | *20.12.19* | *3.95* | *8.20* |
| *CL1 W4* | *1* | *6.1.20* | *3.99* | *8.18* |
| *CL1 W5* | *1* | *16.1.20* | *3.96* | *8.30* |
| *CL1 W6* | *1* | *23.1.20* | *3.98* | *8.40* |
| *CL1 W6 D2* | *1* | *24.1.20* | *4.08* | *8.42* |
| *CL1 W7* | *1* | *28.1.20* | *4.08* | *8.41* |
| *CL1 W8* | *1* | *6.2.20* | *4.14* | *8.50* |
| *CL1 W9* | *1* | *10.2.20* | *4.21* | *8.58* |
| *CL1 W10* | *1* | *18.2.20* | *4.29* | *8.64* |
| *CL2 W1 D1* | *2* | *24.2.20* | *4.38* | *8.53* |
| *CL2 W1 D4* | *2* | *27.2.20* | *4.39* | *8.63* |
| *CL2 W2* | *2* | *2.3.20* | *4.42* | *8.64* |
| *CL2 W3* | *2* | *9.3.20* | *4.48* | *8.75* |
| *CL2 W4* | *2* | *16.3.20* | *4.61* | *8.62* |
| *CL2 W5* | *2* | *26.3.20* | *4.74* | *8.67* |
| *CL2 W6* | *2* | *31.3.20* | *4.82* | *8.64* |
| *CL2 W7* | *2* | *7.4.20* | *4.75* | *8.53* |
| *CL2 W8* | *2* | *14.4.20* | *4.86* | *8.48* |
| *CL2 W9* | *2* | *23.4.20* | *5.03* | *8.47* |
| *CL2 W10* | *2* | *30.4.20* | *5.12* | *8.43* |
| *CL3 W1 D1* | *3* | *4.5.20* | *5.11* | *8.41* |
| *CL3 W1 D5* | *3* | *8.5.20* | *5.12* | *8.38* |
| *CL3 W2* | *3* | *12.5.20* | *5.17* | *8.36* |
| *CL3 W3* | *3* | *19.5.20* | *5.21* | *8.29* |
| *CL3 W4* | *3* | *26.5.20* | *5.13* | *8.27* |
| *CL3 W5* | *3* | *4.6.20* | *5.09* | *8.17* |
| *CL3 W6* | *3* | *11.6.20* | *5.06* | *8.12* |
| *CL3 W7* | *3* | *18.6.20* | *5.01* | *8.08* |
| *CL3 W8* | *3* | *25.6.20* | *4.96* | *8.04* |
| *CL3 W9* | *3* | *2.7.20* | *4.90* | *7.98* |
| *CL3 W10* | *3* | *9.7.20* | *4.90* | *8.01* |
| *CL4 W1 D1* | *4* | *15.7.20* | *4.87* | *8.00* |
| *CL4 W1 D4* | *4* | *17.7.20* | *4.76* | *8.00* |
| *CL4 W2* | *4* | *22.7.20* | *4.72* | *7.97* |
| *CL4 W3* | *4* | *27.7.20* | *4.67* | *7.92* |
| *CL4 W4* | *4* | *6.8.20* | *4.62* | *7.91* |
| *CL4 W5* | *4* | *13.8.20* | *4.57* | *7.92* |
| *CL4 W6* | *4* | *20.8.20* | *4.51* | *7.93* |
| *CL4 W7* | *4* | *25.8.20* | *4.47* | *7.90* |
| *CL4 W8* | *4* | *31.8.20* | *4.37* | *7.88* |
| *CL4 W9* | *4* | *7.9.20* | *4.31* | *7.87* |
| *CL4 W10* | *4* | *14.9.20* | *4.28* | *7.87* |
| *CL4 W11 D1* | *4* | *22.9.20* | *4.19* | *7.84* |
| *CL4 W12* | *4* | *28.9.20* | *4.11* | *7.83* |
| *CL4 W13 D1* | *4* | *5.10.20* | *4.00* | *7.82* |

***Table S5:*** *Average concentration, RSD (1σ in %), literature values, accuracy in comparison to literature values and number of measurements of the reference materials SLRS-6, SLEW-3, in-house reference materials (South Atlantic surface water and South Atlantic Gyre water) and NASS-6 measured with ICP-MS. Average concentration, RSD and accuracy values displayed here are averaged from single measuring days. Cr values are analysed after dilution of the samples and all other elements were analyses after preconcentration with a SeaFAST system. NRCC-National Research Council Canada. \*Values originated from 1:10 dilution of SLRS-6. See also Schmidt et al.,* *2022.*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *Reference  Materials* | *Cr* | *Mn* | *Ni* | *Cu* | *Zn* | *Cd* | *Pb* |
| ***SLRS-6*** | *nmol kg-1* | *nmol kg-1* | *nmol kg-1* | *nmol kg-1* | *nmol kg-1* | *nmol kg-1* | *nmol kg-1* |
| *Average conc.* | *4732* | *52956* | *9811* | *338014\** | *31391\** | *62* | *786* |
| *RSD%* | *3.5* | *3.9* | *6.0* | *1.7\** | *7.2\** | *12.8* | *0.8* |
| *Yeghicheyan  et al.,* *2019* | *4509* | *38616* | *10496* | *376378\** | *26920\** | *56* | *820* |
| *Accuracy* | *0.96* | *0.74* | *1.08* | *1.11\** | *0.86\** | *0.90* | *1.04* |
| *Number* | *4* | *11* | *11* | *13\** | *13\** | *7* | *7* |
| ***SLEW-3*** |  |  |  |  |  |  |  |
| *Average conc.* |  | *40007* | *17508* | *22907* | *4442* | *343* |  |
| *RSD%* |  | *4.3* | *3.5* | *4.2* | *9.1* | *4.8* |  |
| *Leonhard et al.,* *2019* |  | *29326* | *20958* | *24409* | *3074* | *427* |  |
| *Accuracy* |  | *0.74* | *1.21* | *1.07* | *0.78* | *1.28* |  |
| *Number* |  | *12* | *12* | *12* | *12* | *12* |  |
| *South Atlantic Gyre water* | | |  |  |  |  |  |
| *Average conc.* |  | *1615* | *2189* | *2649* | *5614* |  |  |
| *RSD%* |  | *6.2* | *3.7* | *5.3* | *13.2* |  |  |
| *Number* |  | *10* | *10* | *10* | *10* |  |  |
| *South Atlantic surface water* | | |  |  |  |  |  |
| *Average conc.* |  | *1959* | *2417* | *2646* | *39718* |  |  |
| *RSD%* |  | *6.8* | *2.8* | *5.8* | *2.2* |  |  |
| *Number* |  | *6* | *6* | *6* | *6* |  |  |
| ***NASS-6*** |  |  |  |  |  |  |  |
| *Average conc.* | *6747* | *11162* | *3557* | *5206* | *5158* | *169* |  |
| *RSD%* | *15.9* | *5.2* | *3.2* | *3.0* | *25.3* | *7.0* |  |
| *NRCC* | *2293* | *9654* | *5129* | *3528* | *3931* | *165* |  |
| *Accuracy* | *0.34* | *0.87* | *0.76* | *0.35* | *0.81* | *0.98* |  |
| *Number* | *9* | *11* | *11* | *11* | *11* | *2* |  |

***Table S6:*** *Average concentration, RSD (1σ in %), literature values, accuracy in comparison to literature values and number of measurements of the reference materials NIST SRM 614, JCt-1, JCp-1, MACS-3 and ECRM752-1 measured with LA-ICP-MS. For the ECRM752-1 no reported values for the elements of interest are available, which is also the case for some elements in other reference materials. The Hg/Ca values in the NIST glasses are not reliable as Hg is volatile and most likely volatilized during the glass formation. Average concentration, RSD and accuracy values displayed here are averaged from single measuring days.*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Reference materials* | *Cr/Ca* | *Mn/Ca* | *Ni/Ca* | *Cu/Ca* | *Zn/Ca* | *Ag/Ca* | *Cd/Ca* | *Sn/Ca* | *Hg/Ca* | *Pb/Ca* |
| *NIST SRM 614* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* |
| *Mean value* | *14.30* | *10.93* | *9.74* | *10.22* | *85.88* | *1.82* | *3.13* | *6.05* | *0.28* | *5.70* |
| *RSD%* | *6.89* | *6.04* | *10.77* | *2.31* | *1.80* | *2.88* | *4.95* | *2.96* | *45.43* | *3.29* |
| *Jochum et al.,* *2011* | *10.78* | *12.18* | *8.83* | *10.16* | *20.11* | *1.83* | *2.35* | *6.67* |  | *5.28* |
| *Accuracy* | *0.79* | *1.12* | *0.93* | *0.99* | *0.23* | *1.01* | *0.79* | *1.11* |  | *0.93* |
| *Number of spots* | *24* | *24* | *24* | *24* | *24* | *24* | *24* | *24* | *12* | *24* |
| *MACS-3* | *mmol mol-1* | *mmol mol-1* | *mmol mol-1* | *mmol mol-1* | *mmol mol-1* | *mmol mol-1* | *mmol mol-1* | *mmol mol-1* | *µmol mol-1* | *mmol mol-1* |
| *Mean value* | *0.21* | *0.96* | *0.09* | *0.18* | *0.15* | *0.06* | *0.05* | *0.04* | *5.41* | *0.03* |
| *RSD%* | *1.08* | *1.39* | *1.28* | *1.27* | *1.96* | *4.51* | *2.53* | *2.05* | *11.41* | *2.51* |
| *Jochum et al.,* *2019* | *0.23* | *0.99* | *0.10* | *0.19* | *0.20* | *0.05* | *0.05* | *0.05* | *5.41* | *0.03* |
| *Accuracy* | *1.10* | *1.04* | *1.10* | *1.10* | *1.39* | *0.87* | *1.11* | *1.16* | *1.00* | *1.20* |
| *Number of spots* | *22* | *22* | *22* | *22* | *22* | *22* | *22* | *22* | *22* | *22* |
| *JCt-1NP* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* |
| *Mean value* | *8.70* | *0.78* | *0.61* | *1.19* | *1.95* | *0.003* | *0.08* | *0.01* | *0.20* | *0.07* |
| *RSD%* | *2.40* | *3.31* | *3.52* | *3.71* | *6.30* | *26.03* | *24.17* | *10.77* | *20.54* | *2.65* |
| *Jochum et al., 2019* | *0.93* | *1.01* | *1.03* | *1.48* |  |  |  |  |  | *0.06* |
| *Accuracy* | *0.03* | *0.55* | *0.33* | *1.20* |  |  |  |  |  | *0.71* |
| *Number of spots* | *38* | *38* | *38* | *38* | *38* | *36* | *38* | *38* | *29* | *38* |
| *JCp-1NP* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* |
| *Mean value* | *11.93* | *1.63* | *1.77* | *0.92* | *1.59* | *0.01* | *0.07* | *0.07* | *0.02* | *0.14* |
| *RSD%* | *6.30* | *5.22* | *6.39* | *4.42* | *5.21* | *12.29* | *12.56* | *10.49* | *14.81* | *4.85* |
| *Jochum et al., 2019* | *1.27* | *2.16* | *1.05* | *1.29* | *3.53* |  |  |  |  | *0.15* |
| *Accuracy* | *5.78* | *0.61* | *4.72* | *1.26* | *0.51* |  |  |  |  | *0.67* |
| *Number of spots* | *34* | *34* | *34* | *34* | *34* | *34* | *34* | *34* | *20* | *34* |
| *ECRM752-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* | *µmol mol-1* |
| *Mean value* | *162.31* | *4.77* | *2.75* | *10.60* | *0.005* | *0.59* | *0.06* | *0.05* | *0.92* | *0.92* |
| *RSD%* | *2.25* | *5.41* | *5.76* | *3.51* | *16.41* | *2.29* | *5.79* | *18.44* | *5.56* | *5.56* |
| *Number of spots* | *22* | *22* | *22* | *22* | *22* | *22* | *22* | *19* | *22* | *22* |

***References***

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