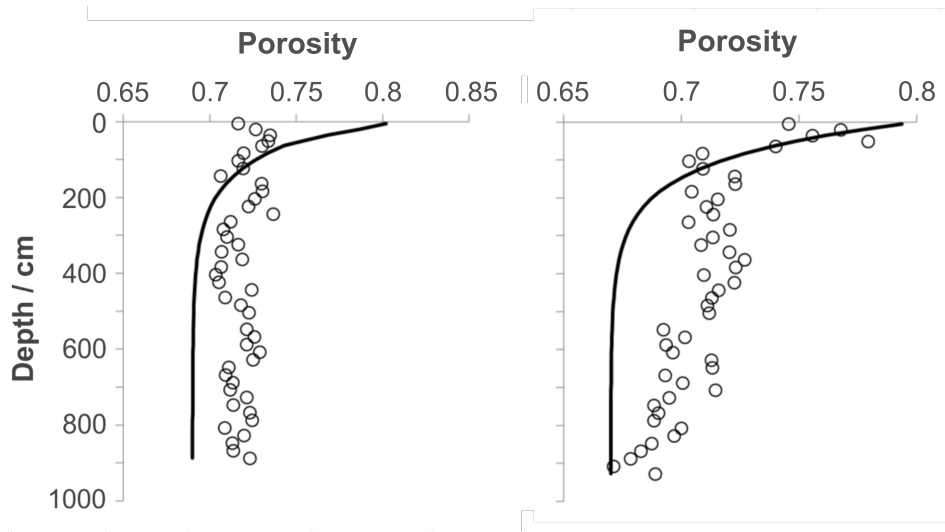


1 **SUPPLEMENTARY MATERIAL**

2 **Supplementary Figure 1:** Measured porosity (dots) and numerical approximation (solid line)
3 for the BGR-RA (left) and IOM (right) sites. See Supplementary Table 2 for fitting details.



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6 **Supplementary Table 1:** Electron-equivalent redox reactions used in the transient transport-
7 reaction model for the 1-day old EBS disturbance in the BGR-RA area and for the 20-year old
8 IOM-BIE disturbance in the IOM area.

Reaction name	Reaction	Redox reaction
Aerobic respiration	R ₁	$(CH_2O)(NH_4^+)_{\frac{16}{106}} + O_2 \rightarrow CO_2 + \frac{16}{106}NH_4^+ + H_2O$
Heterotrophic denitrification	R ₂	$5(CH_2O)(NH_4^+)_{\frac{16}{106}} + 4NO_3^- + 4H^+ \rightarrow 2N_2 + 5CO_2 + 5\frac{16}{106}NH_4^+ + 7H_2O$
Dissimilatory Mn(IV) reduction	R ₃	$(CH_2O)(NH_4^+)_{\frac{16}{106}} + 2MnO_2 + 4H^+ \rightarrow 2Mn^{2+} + CO_2 + \frac{16}{106}NH_4^+ + 3H_2O$
Mn ²⁺ oxidation	R ₄	$2Mn^{2+} + O_2 + 2H_2O \rightarrow 2MnO_2 + 4H^+$
Nitrification	R ₅	$NH_4^+ + 2O_2 \rightarrow NO_3^- + 2H^+ + H_2O$
Mn-anammox	R ₆	$3MnO_2 + 2NH_4^+ + 4H^+ \rightarrow 3Mn^{2+} + N_2 + 6H_2O$

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11 **Supplementary Table 2:** Species, parameter values and boundary conditions used in the
 12 transient transport-reaction models for the 1-day old EBS disturbance in the BGR-RA area and
 13 the 20-year old IOM-BIE disturbance in the IOM area.

	Symbol	Unit	BGR	IOM
<i>Species and boundary conditions</i>				
Porosity at SWI	φ_0		0.82	0.8
Porosity at compacted depth	φ_∞		0.69	0.67
Sedimentation rate	ω_i	cm kyr ⁻¹	0.65	1.15
Oxygen _{bw}	O_2	μM	120	150
Ammonium _{bw}	NH_4^+	μM	1	1
Nitrate _{bw}	NO_3^-	μM	50	38
Dissolved reduced manganese _{bw}	Mn^{2+}	μM	1	1
<i>Fitted parameters</i>				
Sediment thickness		m	10	10
Removed sediment thickness		cm	10	7
Labile C _{org}	TOC_1	mol m ⁻² yr ⁻¹	6.0E-02	4.5E-02
Metabolizable C _{org}	TOC_2	mol m ⁻² yr ⁻¹	1.2E-04	1.1E-03
Refractory C _{org}	TOC_3	mol m ⁻² yr ⁻¹	5.0E-04	7.8E-04
Oxygen _{bas}	O_2	μM	18	55
Ammonium _{bas}	NH_4^+	μM	1	1
Nitrate _{bas}	NO_3^-	μM	19	30
Dissolved reduced manganese _{bas}	Mn^{2+}	μM	1	1
1 st order deg. coeff. TOC ₁	σ_1	yr ⁻¹	1.0E-03	1.0E-02
1 st order deg. coeff. TOC ₂	σ_2	yr ⁻¹	1.0E-06	5.5E-06
1 st order deg. coeff. TOC ₃	σ_3	yr ⁻¹	2.0E-09	2.5E-09
Bioturbation coefficient	B_0	cm ² yr ⁻¹	0.5	0.2
Biomixing half depth	z_{mix}	cm	7.0	7.0
Biomixing attenuation	zz_{att}	cm	0.1	0.1
Bioirrigation coefficient	α_0	yr ⁻¹	0.65	2.0
O ₂ inhibition concentration for R ₁	h_1	μM	0.008	0.006
NO ₃ ⁻ inhibition concentration for R ₂	h_2	μM	45	25
R ₄ rate constant	k_4	μM ⁻¹ yr ⁻¹	0.1	0.1
R ₅ rate constant	k_5	μM ⁻¹ yr ⁻¹	0.005	0.1
R ₆ rate constant	k_6	μM ⁻¹ yr ⁻¹	0.001	0.001

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16 **Supplementary Table 3:** Electron-equivalent redox reactions and associated expressions
 17 used in the numerical diagenetic model.

Reaction name	Reaction	Rate expression
Aerobic respiration	R ₁	$(\sigma_1 C_{TOC1} + \sigma_2 C_{TOC2} + \sigma_3 C_{TOC3}) \frac{C_{O_2}}{C_{O_2} + h_1}$
Heterotrophic denitrification	R ₂	$(\sigma_1 C_{TOC1} + \sigma_2 C_{TOC2} + \sigma_3 C_{TOC3}) \gamma \frac{C_{NO_3^-}}{C_{NO_3^-} + h_2}$
Dissimilatory Mn(IV) reduction	R ₃	$(\sigma_1 C_{TOC1} + \sigma_2 C_{TOC2} + \sigma_3 C_{TOC3}) \gamma \frac{h_2}{C_{NO_3^-} + h_2}$
Mn ²⁺ oxidation	R ₄	$k_4 C_{O_2} C_{Mn^{2+}}$
Nitrification	R ₅	$k_5 C_{O_2} C_{NH_4^+}$
Mn-annamox	R ₆	$k_6 C_{NH_4^+} C_{MnO_2} \gamma \frac{h_2}{C_{NO_3^-} + h_2}$

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$$\gamma = \frac{h_1}{(h_1 + C_{O_2})}$$

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