Supplementary Information for

A new perspective for research on the mechanism and kinetic model of aggregation between coastal spilled oil and suspended sediment

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As shown in Fig. S1, illite showed a thick foliated morphology comprising expanded lamellar structures, accompanied by extensive surface coverage of micron-scale particulate matter. Quartz sand displayed complex architectures combining both stratified planar configurations and amorphous fibrous assemblies. Similarly, montmorillonite had an obvious sheet-like structure, with regular edges and no cotton-like or fine granular debris. Kaolin represented comparatively underdeveloped sheet morphology characterized by substantial surface asperities and topological irregularities. Morphometric evaluation suggested two distinct geometric configurations: angular embedment within oil droplets or tangential surface contact, with specific orientation preferences observed for different mineral types.

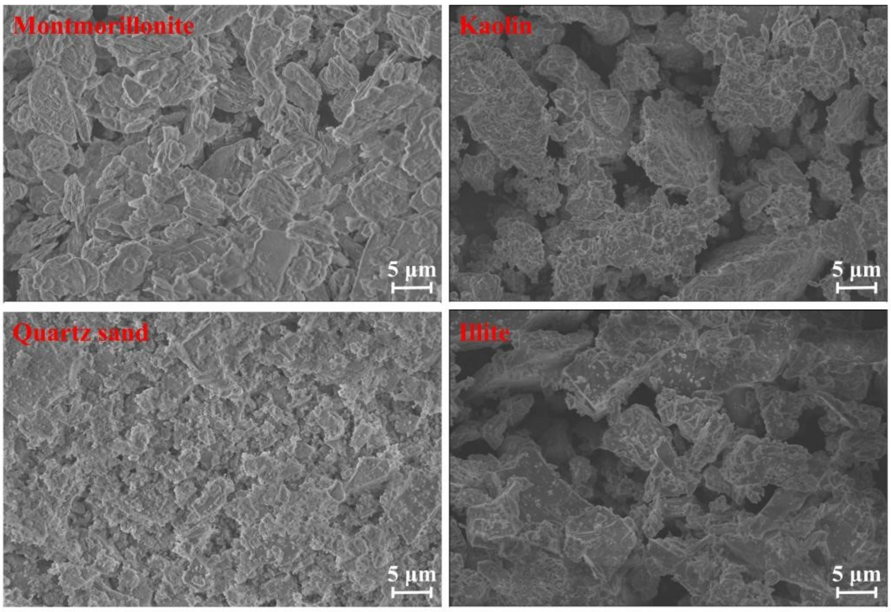

Fig. S1. SEM images of the four mineral particles

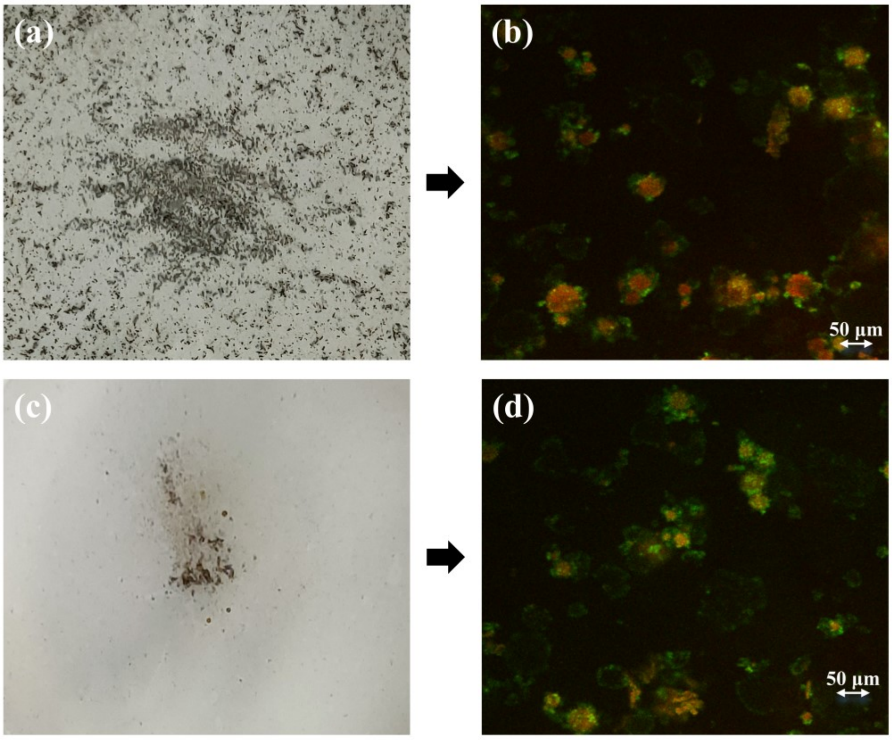

Fig. S2. Real and confocal scanning images of OMAs formed by (a,b) montmorillonite and (c,d) natural sediment

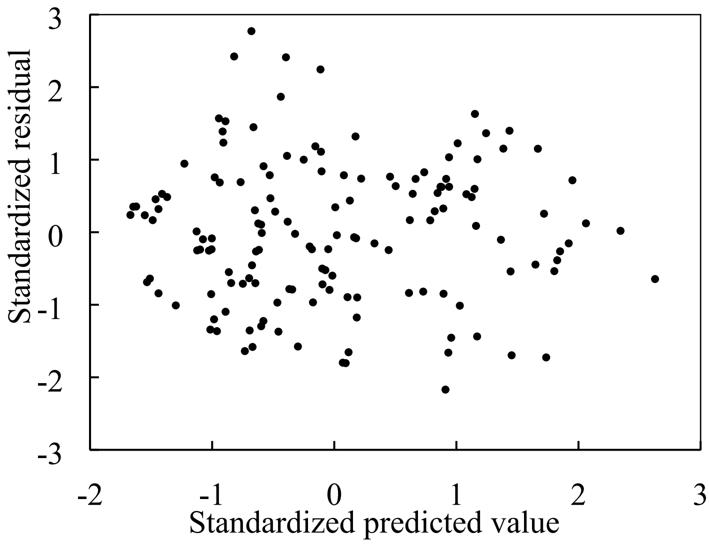

Fig. S3. Plot of observed values accquired by the OMA density prediction model versus residuals

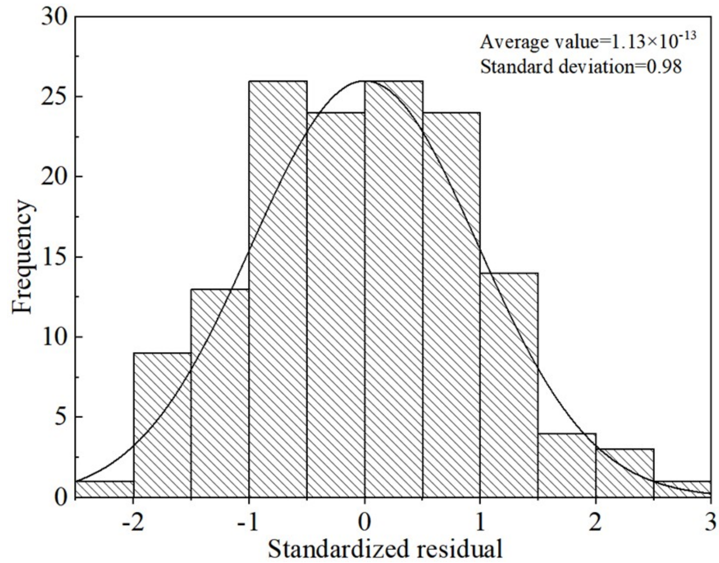

Fig. S4. Frequence histogram of the residual values for OMA density prediction model

Table S1 Basic data of the predictive model for oil dispersion

Oil type	T (°C)	ODE_e (%)	Hs (cm)	ρ_{oil} (kg/m^3)	μ_{oil} (mm^2/s)	IFT_{ow} (mN/m)
Oman	15	35.77	4.011	872	392	13.58
Iranian	15	24.52	4.011	927	1171	22.24
Iranian	15	21.46	2.713	927	1171	22.24
Iranian	15	12.89	1.921	927	1171	22.24
Iranian	25	43.83	4.011	927	417	16.00
Iranian	25	29.02	2.713	927	417	16.00
Iranian	25	20.11	1.921	927	417	16.00
Roncador	10	16.53	4.011	943	3752	31.53
Roncador	15	17.43	4.011	943	2476	27.57
Roncador	15	12.14	2.713	943	2476	27.57
Roncador	15	4.40	1.921	943	2476	27.57
Roncador	20	21.83	4.011	943	1580	26.27
Roncador	25	28.81	4.011	943	1249	22.77
Roncador	25	20.64	2.713	943	1249	22.77
Roncador	25	12.25	1.921	943	1249	22.77
Merey	15	3.94	4.011	952	8309	36.22
Merey	15	2.73	2.713	952	8309	36.22
Merey	15	1.41	1.921	952	8309	36.22
Merey	25	7.04	4.011	952	3543	25.80
Merey	25	4.93	2.713	952	3543	25.80
Merey	25	3.41	1.921	952	3543	25.80
180$^{\#}$fuel	15	1.93	4.011	982	26113	46.50

Section S1. Model development

The temporal reduction of dispersed oil in the water column can be attributed to the progressive formation of OMA. Based on this premise, the dynamic variation of oil content within OMA over time can be mathematically described as:

$$\frac{\mathrm{d}m_{\mathrm{oma}}}{\mathrm{d}t} = -1.3\alpha\left(\frac{\varepsilon}{\upsilon}\right)^{\frac{1}{2}}(m_{\mathrm{oil0}} - m_{\mathrm{oma}})C_{\mathrm{par}} \tag{1}$$

where m_{oma} is the mass of trapped oil in OMA (kg), m_{oil0} is the mass of dispersed oil in the water column (kg). t=0 min, m_{oma}=0 kg.

Under the assumption of uniform density in OMA, the density can be calculated as the ratio of the combined mass of constituent oil droplets and mineral particles to the total volume of OMA:

$$\rho_{\mathrm{oma}} = \frac{m_{\mathrm{oma}} + V(C_{\mathrm{par0}} - C_{\mathrm{par}})}{m_{\mathrm{oma}} / \rho_{\mathrm{oil}} + V(C_{\mathrm{par0}} - C_{\mathrm{par}}) / \rho_{\mathrm{par}}} \tag{2}$$

where C_{par0} is the initial mass concentration of SPM, ρ_{par}, ρ_{oil}, ρ_{oma} are the density of SPM, dispersed oil and formed OMA (kg/m^3), V is the volume of the solution (m^3). Converting Eq. (3) to express the mass concentration of SPM (C_{par}) at time t:

$$C_{par} = C_{par0} - \frac{\rho_{par}(\rho_{oma} - \rho_{oil})}{\rho_{oil}(\rho_{par} - \rho_{osa})}\frac{m_{oma}}{V} \tag{3}$$

By substituting Eq. (4) into Eq. (2), analytical solution of the differential equation was obtained, and the kinetic model of m_{oma} can be expressed as:

$$m_{oma} == M_{oil0} \cdot ODE \frac{1-\exp(A(C_{par0} - B)t)}{B/C_{par0} - \exp(A(C_{par0} - B)t)} \tag{4}$$

$$A = -1.3\alpha(\frac{\varepsilon}{\upsilon})^{\frac{1}{2}}, \quad B = \frac{\rho_{par}(\rho_{oma} - \rho_{oil})}{\rho_{oil}(\rho_{par} - \rho_{oma})}\frac{m_{oil0}}{V} \tag{5}$$

where M_{oil0} is the initial mass of spilled oil (kg); oil dispersion efficiency (*ODE*) is a characterization parameter for oil dispersion.