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Potential of various minerals and their biogeochemical implications for ocean alkalinity enhancement in the southeastern Arabian Sea

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Contents

Text S1: XRF and XRD analysis

The chemical composition analysis of the minerals was carried out using X-ray fluorescence spectrometry (XRF), and the oxide concentrations were measured in an X-Ray Fluorescent (XRF) spectrometer (Rigaku®). For determining the loss of ignition (LOI), powdered sample was heated overnight at 100°C to remove the moisture. A 5g of this sample was accurately weighed and heated in a preheated muffle furnace (Thermo®) at 1050°C. LOI corresponded to the loss of weight in percentage. For XRF analysis, 4 g of sample was weighed and mixed with 1 g of wax binder (Chemplex®) in an agate mortar. Thin pellets for XRF were formed from the mixture by transferring it into standard aluminium cups and pressing against a compressor. For calibration, pallets of international rock standards were used. The XRF instrument was operated at 50 KV, and P10 gas flow rate was 24.7mL min^{-1}.

The mineral phases were identified using the X-ray diffraction (XRD) technique. The XRD measurements were performed using a D2 PHASER, Bruker®, with a Cu target (λ =1.54056 Å) and Ni filter operated at 30 KV voltage and 20 mA current. The diffraction patterns obtained were compared with the International Centre for Diffraction Data (ICDD®) database for mineral identification. The diffraction patterns obtained are shown in Figure S2.
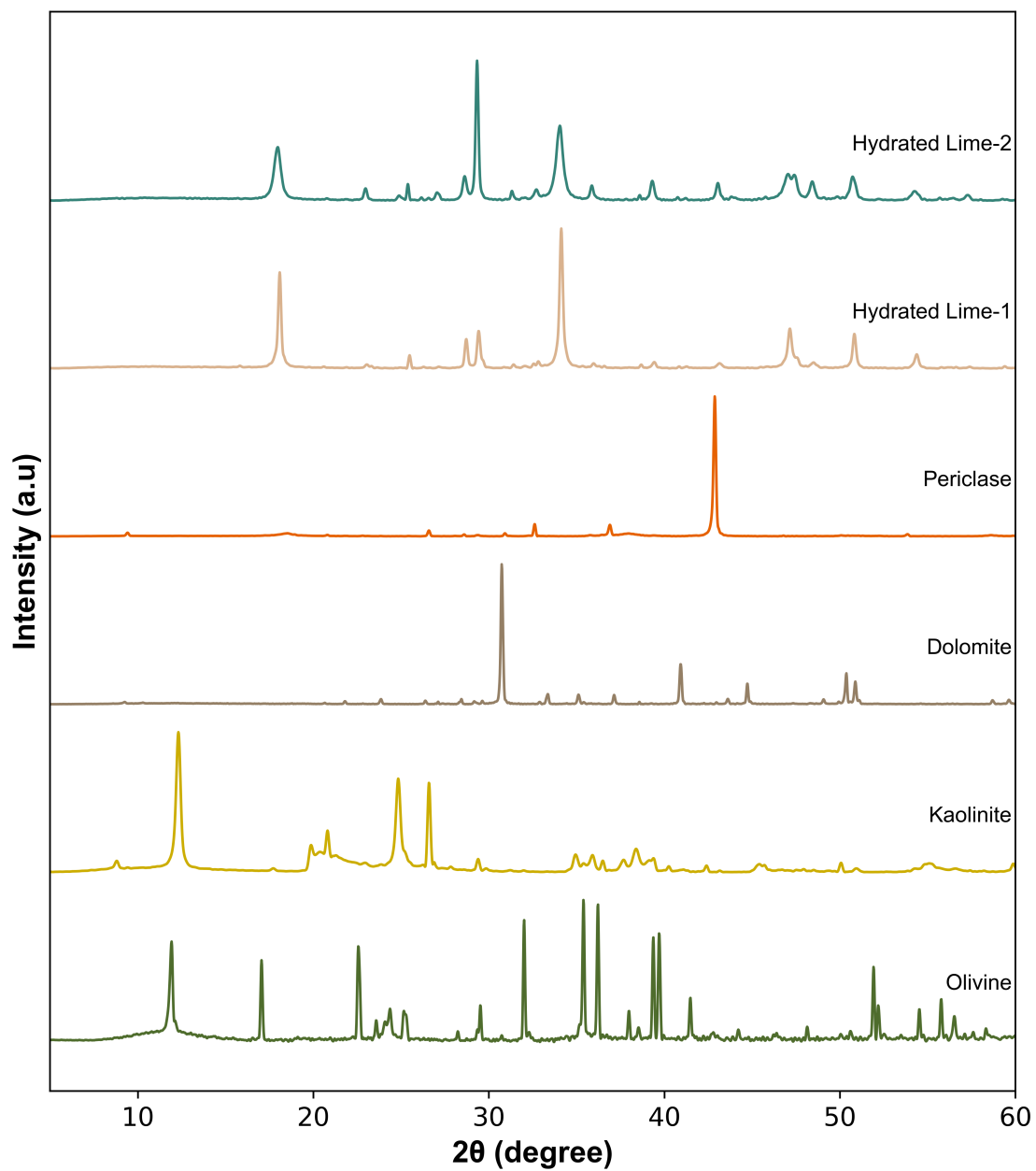
Figure S1: XRD profiles of various powdered minerals. The x-axis represents the diffraction angle (2θ), while the y-axis shows the normalized intensity.

Table S1. GAMs summary: The "**Estimate**" is the mean effect (the measure of mean differences between the groups). A positive estimate indicates that the estimated mean effect of treatment is higher than the reference (control or any other treatment), while a negative estimate indicates a lower effect. "***P*-means**" and "***P*-smooths**" represent the p value of the estimated mean and for the smooth terms, respectively. The p value of <0.05 indicates statistically significant differences in either the means or the trends between groups. $\mathbf{R_{adj}}$ is the adjusted R^2 value.

Variable	Treatment Comparison	Estimate	*P*−means	*P*-smooths	$\mathbf{R_{adj}}$
Alkalinity	Control - olivine (+250)	-5	0.8	0.2	
	Control - olivine (+500)	-22	0.2	0.07	
	Control - kaolinite (+250)	15	0.4	0.2	
	Control - dolomite (+250)	-2	0.9	0.2	0.92
	Control - hydrated lime-1 (+250)	122	<0.05	0.4	
	Control - hydrated lime-2 (+250)	145	<0.05	0.2	
	Control - hydrated lime-2 (+500)	364	<0.05	<0.05	
	Control - Periclase (+500)	363	<0.05	<0.05	
	olivine (+250) - olivine (+500)	-17	0.5	0.5	
	hydrated lime-2 (+250) - hydrated lime-2 (+500)	219	<0.05	0.05	
pH	Control - olivine (+250)	0.06	<0.05	<0.05	
	Control - olivine (+500)	0.05	<0.05	0.08	
	Control - kaolinite (+250)	0.08	<0.05	<0.05	
	Control - dolomite (+250)	0.08	<0.05	<0.05	0.90
	Control - hydrated lime-1 (+250)	0.2	<0.05	0.1	
	Control - hydrated lime-2 (+250)	0.3	<0.05	0.3	
	Control - hydrated lime 2 (+500)	0.4	<0.05	<0.05	
	Control - Periclase (+500)	0.5	<0.05	<0.05	
	olivine (+250) - olivine (+500)	-0.01	0.7	0.5	
	hydrated lime-2 (+250) - hydrated lime-2 (+500)	0.2	<0.05	<0.05	
DIC	Control - olivine (+250)	-29	0.2	<0.05	
	Control - olivine (+500)	-24	0.3	0.2	
	Control - kaolinite (+250)	-42	0.05	<0.05	
	Control - dolomite (+250)	-23	0.3	<0.05	0.72
	Control - hydrated lime-1 (+250)	-2	0.9	0.4	
	Control - hydrated lime-2 (+250)	17	0.5	0.4	
	Control - hydrated lime 2 (+500)	90	<0.05	<0.05	
	Control - Periclase (+500)	32	0.1	0.08	
	olivine (+250) - olivine (+500)	5	0.8	0.4	
	hydrated lime-2 (+250) - hydrated lime-2 (+500)	73	<0.05	<0.05	
$\Omega_{calcite}$	Control - olivine (+250)	0.4	0.1	0.4	
	Control - olivine (+500)	0.3	0.1	0.2	
	Control - kaolinite (+250)	0.5	<0.05	0.3	
	Control - dolomite (+250)	0.6	<0.05	0.2	0.92
	Control - hydrated lime-1 (+250)	1.9	<0.05	0.5	
	Control - hydrated lime-2 (+250)	2.1	<0.05	0.3	
	Control - hydrated lime 2 (+500)	4.2	<0.05	<0.05	

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	Control - Periclase (+500)	5.5	<0.05	<0.05	
	olivine (+250) - olivine (+500)	-0.05	0.8	0.8	
	hydrated lime-2 (+250) - hydrated lime-2 (+500)	2.1	<0.05	<0.05	
$\Omega_{aragonite}$	Control - olivine (+250)	0.2	01	0.4	0.92
	Control - olivine (+500)	0.2	0.1	0.3	
	Control - kaolinite (+250)	0.3	<0.05	0.3	
	Control - dolomite (+250)	0.4	<0.05	0.2	
	Control - hydrated lime-1 (+250)	1.2	<0.05	0.5	
	Control - hydrated lime-2 (+250)	1.4	<0.05	0.4	
	Control - hydrated lime 2 (+500)	2.8	<0.05	<0.05	
	Control - Periclase (+500)	3.7	<0.05	<0.05	
	olivine (+250) - olivine (+500)	-0.02	0.8	0.8	
	hydrated lime-2 (+250) - hydrated lime-2 (+500)	1.4	<0.05	<0.05	
$p\mathrm{CO}_2$	Control - olivine (+250)	-176	<0.05	<0.05	0.91
	Control - olivine (+500)	-149	<0.05	<0.05	
	Control - kaolinite (+250)	-202	<0.05	<0.05	
	Control - dolomite (+250)	-212	<0.05	<0.05	
	Control - hydrated lime-1 (+250)	-489	<0.05	<0.05	
	Control - hydrated lime-2 (+250)	-512	<0.05	<0.05	
	Control - hydrated lime 2 (+500)	-673	<0.05	<0.05	
	Control - Periclase (+500)	-785	<0.05	<0.05	
	olivine (+250) - olivine (+500)	25	0.5	0.1	
	hydrated lime-2 (+250) - hydrated lime-2 (+500)	-158	<0.05	<0.05	
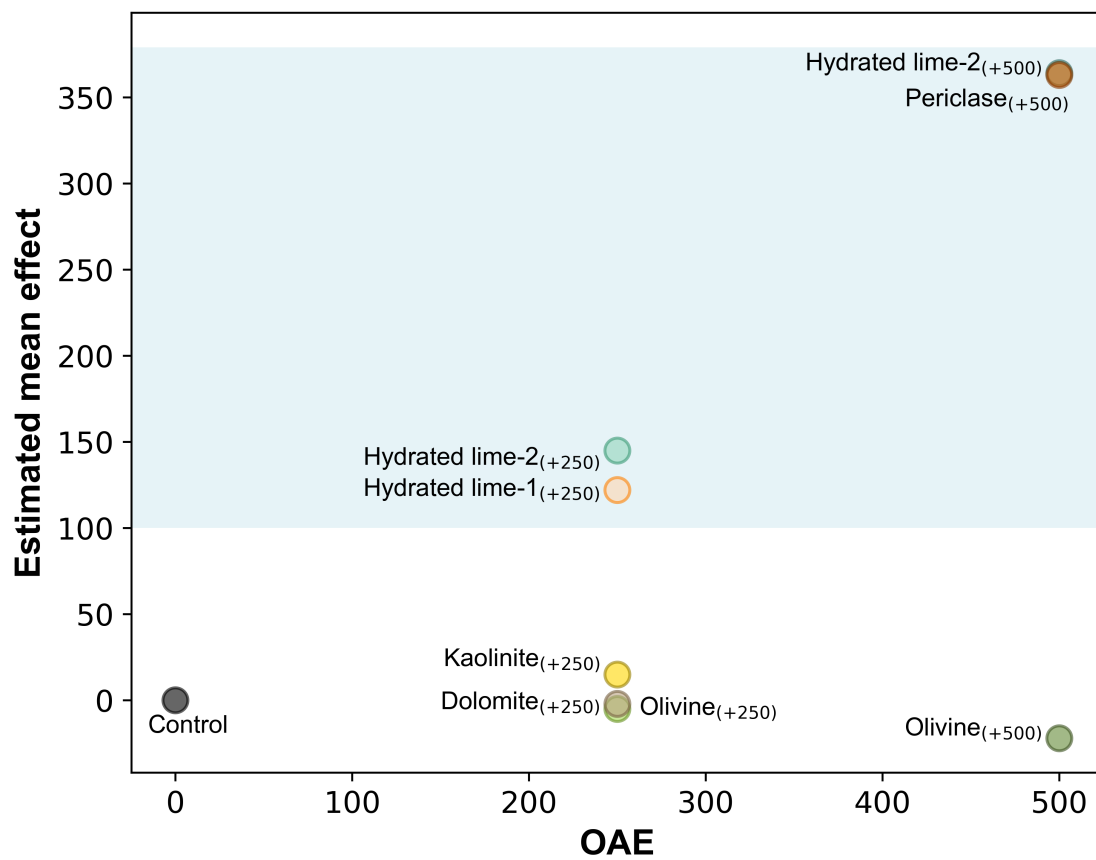
Figure S2: Estimated mean effect (difference in the mean of treatment and control) for various treatments and control over a period of nine days. The x-axis represents the amount of added alkalinity, whereas the y-axis represents the mean effect. The shaded blue region depicts mean effects for mesocosms to which industrially produced minerals were added.