Table S1. XRF Determination of Elemental Composition for Uncalcined and Calcined Shells

Element	Uncalcined mussel (ppm)	Calcined mussel (ppm)	Uncalcined oyster (ppm)	Calcined oyster (ppm)	Uncalcined eggshell (ppm)	Calcined eggshell (ppm)	Uncalcined lobster shell (ppm)	Calcined lobster shell (ppm)
Mo		15.4±9.29	7.56±2.2	18±11.96			11.48±0.57	29.59±4.81
Sr	1111±0.4	1818±0.37	792.95±1.6	1257.6±0.6	196±0.79	342.5±0.95	1997±0.29	4888.6±0.6
Rb							69.94±1.39	
Pb				8.25±8.2			6.76±12.09	11.93±14.3
Zn			21±8.37	46.49±10.6		16.91±12.3	24.31±0.62	53.32±13.11
W		91.8±18.4	119.9±38.7	136.7±17.9		99.5±18.55		154.2±17.4
Cu		868.8±0.8	35.8±4.39	82.49±1.97				116.9±8.12
Fe	1735.3±3.6	3709±1.4	435±12.4	908.6±3	128±9.9	214.49±4.4	55.52±9.23	455.3±3.68
Cr	5.91±1.32	11.14±0.4	28.8±15.3			25.04±21.2	40.58±6.7	81.26±11.9
V	118.7±5.9	108.3±20.3	35.07±27.5	157.2±8.6	103±13.9	86.08±16.8		
Sc	4854.4±0.3	2631.4±0.4	4573.3±0.7	2483.4±0.6	4930±0.2	2514.1±0.6	6123.9±0.1	2512±1.29
Ca (%)	45.52±0.3	69.78±0.2	48.98±0.8	71.99±0.2	45.10±0.3	71.89±0.2	31.57±0.2	71.34±0.4
K	421.6±4	664.55±3.6	610.61±4.6	1208.4±2	710±4.9	665.03±3.1	1609.2±2.3	254±8.14
Sn	1231±1.3	2320.4±0.4		102.2±6.3				
Nb		8.25±5.7					7.16±7.11	13.9±4.6
Bi							43.09±8.66	19.8±7.6
Ti							92.12±43.45	1115±9.2

Table S2: The American Mineralogist Crystallography Database information for the XRD patterns of oxides in the calcined materials

Lime

Fiquet G, Richet P, Montagnac G
Physics and Chemistry of Minerals 27 (1999) 103-111
High-temperature thermal expansion of lime, periclase, corundum and spinel
Sample: PtRh10% heating wire, T = 298 K
database_code_amcsd 0008276
CELL PARAMETERS: 4.8150 4.8150 4.8150 90.000 90.000 90.000
SPACE GROUP: Fm3m
X-RAY WAVELENGTH: 1.541838
Cell Volume: 111.632
Density (g/cm3): 3.336
MAX. ABS. INTENSITY / VOLUME**2: 44.70567536
RIR: 4.363
RIR based on corundum from Acta Crystallographica A38 (1982) 733-739

2-THETA	INTENSITY	D-SPACING	H	K	L	Multiplicity
32.20	38.32	2.7799	1	1	1	8
37.35	100.00	2.4075	2	0	0	6
53.85	52.90	1.7024	2	2	0	12
64.15	12.45	1.4518	3	1	1	24
67.37	14.25	1.3900	2	2	2	8
79.65	5.57	1.2038	4	0	0	6
88.52	4.27	1.1046	3	3	1	24

For reference, see Downs et al. (1993) American Mineralogist 78, 1104-1107.

SrO

Wyckoff R W G
Crystal Structures 1 (1963) 85-237
Second edition. Interscience Publishers, New York, New York
rocksalt structure
_database_code_amcsd 0011405

CELL PARAMETERS: 5.1602 5.1602 5.1602 90.000 90.000 90.000
SPACE GROUP: Fm3m
X-RAY WAVELENGTH: 1.541838
Cell Volume: 137.404
Density (g/cm3): 5.008
MAX. ABS. INTENSITY / VOLUME**2: 116.3840893
RIR: 7.567
RIR based on corundum from Acta Crystallographica A38 (1982) 733-739

2-THETA	INTENSITY	D-SPACING	H	K	L	Multiplicity
29.99	91.42	2.9792	1	1	1	8
34.77	100.00	2.5801	2	0	0	6
49.99	60.49	1.8244	2	2	0	12
59.40	33.58	1.5559	3	1	1	24
62.33	17.82	1.4896	2	2	2	8
73.39	7.24	1.2901	4	0	0	6
81.27	11.48	1.1838	3	3	1	24
83.84	18.31	1.1539	4	2	0	24

For reference, see Downs et al. (1993) American Mineral

K2O

Wyckoff R W G
Crystal Structures 1 (1963) 239-444
Second edition. Interscience Publishers, New York, New York
Anti-fluorite structure
_database_code_amcsd 0011734

CELL PARAMETERS: 6.4360 6.4360 6.4360 90.000 90.000 90.000
SPACE GROUP: Fm3m
X-RAY WAVELENGTH: 1.541838
Cell Volume: 266.593
Density (g/cm3): 2.347
MAX. ABS. INTENSITY / VOLUME**2: 34.64344472
RIR: 4.807
RIR based on corundum from Acta Crystallographica A38 (1982) 733-739

2-THETA	INTENSITY	D-SPACING	H	K	L	Multiplicity
23.95	9.88	3.7158	1	1	1	8
27.72	65.23	3.2180	2	0	0	6
39.61	100.00	2.2755	2	2	0	12
46.82	3.05	1.9405	3	1	1	24
49.03	13.52	1.8579	2	2	2	8
57.26	12.27	1.6090	4	0	0	6
64.78	13.86	1.4391	4	2	0	24
71.86	19.48	1.3137	4	2	2	24
85.31	5.22	1.1377	4	4	0	12

K2 O

Zintl E, Harder A, Dauth B
Zeitschrift fur Elektrochemie 40 (1934) 588-593
Gitterstruktur der Oxide, Sulfide, Selenide und Telluride des Lithiums, Natriums und Kaliums
_cod_database_code 1010878
_database_code_amcsd 0017549
CELL PARAMETERS: 6.4360 6.4360 6.4360 90.000 90.000 90.000
SPACE GROUP: Fm3m
X-RAY WAVELENGTH: 1.541838
Cell Volume: 266.593
Density (g/cm3): 2.347
MAX. ABS. INTENSITY / VOLUME**2: 34.64344472
RIR: 4.807
RIR based on corundum from Acta Crystallographica A38 (1982) 733-739

2-THETA	INTENSITY	D-SPACING	H	K	L	Multiplicity
23.95	9.88	3.7158	1	1	1	8
27.72	65.23	3.2180	2	0	0	6
39.61	100.00	2.2755	2	2	0	12
46.82	3.05	1.9405	3	1	1	24
49.03	13.52	1.8579	2	2	2	8
57.26	12.27	1.6090	4	0	0	6
64.78	13.86	1.4391	4	2	0	24
71.86	19.48	1.3137	4	2	2	24
85.31	5.22	1.1377	4	4	0	12

Periclase/MgO
Hazen R M
American Mineralogist 61 (1976) 266-271
Effects of temperature and pressure on the cell dimension and X-ray temperature
factors of periclase
T = 24 C, P = 1 atm, standard mount
_database_code_amcsd 0000501

CELL PARAMETERS: 4.2110 4.2110 4.2110 90.000 90.000 90.000
SPACE GROUP: Fm3m
X-RAY WAVELENGTH: 1.541838
Cell Volume: 74.672
Density (g/cm3): 3.585
MAX. ABS. INTENSITY / VOLUME**2: 35.75123052
RIR: 3.247
RIR based on corundum from Acta Crystallographica A38 (1982) 733-739

2-THETA	INTENSITY	D-SPACING	H	K	L	Multiplicity
36.97	10.52	2.4312	1	1	1	8
42.96	100.00	2.1055	2	0	0	6
62.37	53.43	1.4888	2	2	0	12
74.77	6.56	1.2697	3	1	1	24
78.72	15.30	1.2156	2	2	2	8

Na2O
Wyckoff R W G
Crystal Structures 1 (1963) 239-444
Second edition. Interscience Publishers, New York, New York
Anti-fluorite structure
_database_code_amcsd 0011742

CELL PARAMETERS: 5.5500 5.5500 5.5500 90.000 90.000 90.000
SPACE GROUP: Fm3m
X-RAY WAVELENGTH: 1.541838
Cell Volume: 170.954
Density (g/cm3): 2.408
MAX. ABS. INTENSITY / VOLUME**2: 22.51046947
RIR: 3.044
RIR based on corundum from Acta Crystallographica A38 (1982) 733-739

2-THETA	INTENSITY	D-SPACING	H	K	L	Multiplicity
27.84	23.86	3.2043	1	1	1	8
32.26	38.15	2.7750	2	0	0	6
46.27	100.00	1.9622	2	2	0	12
54.86	5.82	1.6734	3	1	1	24
57.52	7.94	1.6021	2	2	2	8
67.51	10.77	1.3875	4	0	0	6
74.53	1.48	1.2733	3	3	1	24
76.81	7.26	1.2410	4	2	0	24
85.76	15.93	1.1329	4	2	2	24

Portlandite/Ca(OH)2
Henderson D M, Gutowsky H S
American Mineralogist 47 (1962) 1231-1251
A nuclear magnetic resonance determination of the hydrogen positions in Ca(OH)2
T = -190 C
_database_code_amcsd 0000116

CELL PARAMETERS: 3.5850 3.5850 4.8710 90.000 90.000 120.000
SPACE GROUP: P-3m1
X-RAY WAVELENGTH: 1.541838
Cell Volume: 54.216
Density (g/cm3): 2.269
MAX. ABS. INTENSITY / VOLUME**2: 23.80613776
RIR: 3.416
RIR based on corundum from Acta Crystallographica A38 (1982) 733-739

2-THETA	INTENSITY	D-SPACING	H	K	L	Multiplicity
18.21	63.98	4.8710	0	0	1	2
28.75	16.97	3.1047	1	0	0	6
34.25	2.54	2.6181	1	0	1	6
34.25	97.46	2.6181	0	1	1	6
47.44	17.52	1.9162	1	0	2	6
47.44	23.93	1.9162	0	1	2	6
50.95	27.79	1.7925	1	1	0	6
54.55	14.51	1.6822	1	1	1	12
56.69	1.12	1.6237	0	0	3	2
59.55	1.91	1.5524	2	0	0	6
62.83	9.84	1.4791	2	0	1	6
64.80	1.16	1.4388	0	1	3	6
64.80	9.40	1.4388	1	0	3	6
72.16	4.56	1.3091	2	0	2	6
72.16	3.33	1.3091	0	2	2	6
78.55	1.40	1.2177	0	0	4	2
79.68	1.96	1.2034	1	1	3	12
85.03	1.99	1.1408	1	2	1	12
85.69	1.15	1.1337	1	0	4	6
86.80	3.08	1.1220	0	2	3	6

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Portlandite/Ca(OH)2
Desgranges L, Grebille D, Calvarin g, Chevrier G, Floquet N, Niepce J
Acta Crystallographica B49 (1993) 812-817
Hydrogen thermal motion in calcium hydroxide: Ca (O H)2
_cod_database_code 1001768
_database_code_amcsd 0009874

CELL PARAMETERS: 3.5890 3.5890 4.9110 90.000 90.000 120.000
SPACE GROUP: P-3m1
X-RAY WAVELENGTH: 1.541838
Cell Volume: 54.783
Density (g/cm3): 2.246
MAX. ABS. INTENSITY / VOLUME**2: 24.52345437
RIR: 3.556
RIR based on corundum from Acta Crystallographica A38 (1982) 733-739

2-THETA	INTENSITY	D-SPACING	H	K	L	Multiplicity

18.06	63.14	4.9110	0	0	1	2
28.72	17.21	3.1082	1	0	0	6
34.14	97.31	2.6264	1	0	1	6
34.14	2.69	2.6264	0	1	1	6
47.17	25.16	1.9268	1	0	2	6
47.17	18.80	1.9268	0	1	2	6
50.88	28.52	1.7945	1	1	0	6
54.44	15.85	1.6855	1	1	1	12
56.19	1.35	1.6370	0	0	3	2
59.48	2.23	1.5541	2	0	0	6
62.71	10.64	1.4817	0	2	1	6
64.29	1.12	1.4488	1	1	2	12
64.32	1.36	1.4484	1	0	3	6
64.32	10.47	1.4484	0	1	3	6
71.90	3.89	1.3132	2	0	2	6
71.90	5.23	1.3132	0	2	2	6
77.79	1.66	1.2277	0	0	4	2
79.20	2.59	1.2094	1	1	3	12
84.87	2.35	1.1425	2	1	1	12
84.93	1.42	1.1419	0	1	4	6
86.31	3.70	1.1271	2	0	3	6

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Zincite/ZnO
Kihara K, Donnay G
The Canadian Mineralogist 23 (1985) 647-654
Anharmonic thermal vibrations in ZnO
Model: 2-c, at T = 293 K
_database_code_amcsd 0005203

CELL PARAMETERS: 3.2494 3.2494 5.2038 90.000 90.000 120.000
SPACE GROUP: P6_3mc
X-RAY WAVELENGTH: 1.541838
Cell Volume: 47.584
Density (g/cm3): 5.681
MAX. ABS. INTENSITY / VOLUME**2: 108.5150060
RIR: 6.220
RIR based on corundum from Acta Crystallographica A38 (1982) 733-739

2-THETA	INTENSITY	D-SPACING	H	K	L	Multiplicity
31.80	52.55	2.8141	1	0	0	6
34.47	39.77	2.6019	0	0	2	1
36.29	100.00	2.4753	1	0	1	6
47.60	21.60	1.9104	1	0	2	6
56.65	31.17	1.6247	1	1	0	6
62.94	28.09	1.4766	1	0	3	6
66.45	4.24	1.4070	2	0	0	6
68.03	23.70	1.3781	1	1	2	6
69.16	12.05	1.3583	2	0	1	6
72.68	1.99	1.3010	0	0	4	1
77.05	3.74	1.2377	2	0	2	6
81.51	2.02	1.1809	1	0	4	6
89.74	7.92	1.0927	2	0	3	6

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Zincite/ZnO
Aminoff G/Zeitschrift fur Kristallographie 56 (1921) 495-505
Ueber Lauephotogramme und Struktur von Zinkit.
_cod_database_code 1011258
_database_code_amcsd 0018119
CELL PARAMETERS: 3.2200 3.2200 5.2000 90.000 90.000 120.000
SPACE GROUP: P6_3mc
X-RAY WAVELENGTH: 1.541838
Cell Volume: 46.692
Density (g/cm3): 5.789
MAX. ABS. INTENSITY / VOLUME**2: 116.7488557
RIR: 6.566
RIR based on corundum from Acta Crystallographica A38 (1982) 733-739

2-THETA	INTENSITY	D-SPACING	H	K	L	Multiplicity
32.10	50.47	2.7886	1	0	0	6
34.50	37.91	2.6000	0	0	2	1
36.56	100.00	2.4575	1	0	1	6
47.83	20.89	1.9017	1	0	2	6
57.22	31.02	1.6100	1	1	0	6
63.16	29.96	1.4721	1	0	3	6
67.13	4.31	1.3943	2	0	0	6
68.56	23.92	1.3688	1	1	2	6
69.84	12.85	1.3467	2	0	1	6
72.74	2.18	1.3000	0	0	4	1
77.72	3.87	1.2288	2	0	2	6
81.73	2.27	1.1783	1	0	4	6

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For reference, see Downs et al. (1993) American Mineralogist 78, 1104-1107.

Zincite/ZnO
Wyckoff R W G/Crystal Structures 1 (1963) 85-237
Second edition. Interscience Publishers, New York, New York
Note: wurtzite structure
_database_code_amcsd 0011555
CELL PARAMETERS: 3.2495 3.2495 5.2069 90.000 90.000 120.000
SPACE GROUP: P6_3mc
X-RAY WAVELENGTH: 1.541838
Cell Volume: 47.615
Density (g/cm3): 5.677
MAX. ABS. INTENSITY / VOLUME**2: 125.0959236
RIR: 7.175
RIR based on corundum from Acta Crystallographica A38 (1982) 733-739

2-THETA	INTENSITY	D-SPACING	H	K	L	Multiplicity
31.80	46.52	2.8141	1	0	0	6
34.45	28.62	2.6035	0	0	2	1
36.29	100.00	2.4757	1	0	1	6
47.58	16.31	1.9111	1	0	2	6
56.65	28.86	1.6248	1	1	0	6
62.91	29.32	1.4773	1	0	3	6
66.44	4.02	1.4071	2	0	0	6
68.02	19.35	1.3784	1	1	2	6
69.16	12.68	1.3584	2	0	1	6
72.63	2.22	1.3017	0	0	4	1
77.04	3.16	1.2379	2	0	2	6
81.46	2.31	1.1815	1	0	4	6
89.71	8.77	1.0930	2	0	3	6

For reference, see Downs et al. (1993) American Mineralogist 78, 1104-1107.

Table S3. Percent reduction (PR%) of diesel generator fuel emissions from B20 and B40 relative to ULSPD

	Retention Time (min)	B20 PR%	B40 PR%
Propene	4.37	39%	35%
1,3-Butadiene	5.00	38%	49%
Acetone	6.18	39%	54%
Isopropyl Alcohol	6.47	18%	18%
Methyl Vinyl Ketone	8.53	39%	47%
2-Butanone (Methyl Ethyl Ketone)	8.87	38%	45%
Benzene	11.55	28%	33%
Toluene	15.76	37%	44%
Ethylbenzene	19.28	28%	32%
o-Xylene	20.25	26%	33%
1,2,4-Trimethylbenzene	22.72	19%	20%