

**Table S1** Bulk assay concentrations for the single carbonate minerals samples (ppm unless stated otherwise).

	Magnesite MgCO <sub>3</sub>	Siderite FeCO <sub>3</sub>	Rhodochrosite MnCO <sub>3</sub>	Dolomite CaMg(CO <sub>3</sub> ) <sub>2</sub>	Calcite CaCO <sub>3</sub>	Azurite Cu <sub>3</sub> (CO <sub>3</sub> ) <sub>2</sub> (OH) <sub>2</sub>	Malachite Cu <sub>2</sub> CO <sub>3</sub> (OH) <sub>2</sub>	Ankerite Ca(Fe,Mg,Mn)(CO <sub>3</sub> ) <sub>2</sub>
Ag	<2	<2	82	<2	<2	8	<2	8
Al (wt%)	0.005	0.04	0.04	0.04	0.005	0.56	0.02	0.275
As	<10	40	220	<10	<10	40	20	20
Ba	<20	<20	<20	<20	<20	<20	<20	40
Bi	<20	20	<20	<20	<20	<20	<20	<20
Ca (wt%)	4.08	0.16	2.92	23.2	40.4	0.03	0.02	4.28
Cd	<5	<5	<5	<5	<5	<5	<5	550
Co	<2	18	26	4	<2	<2	116	16
Cr	<20	<20	<20	<20	<20	<20	<20	<20
Cu (wt%)	0.0028	0.0452	0.0088	0.0022	0.002	55.7	59.4	0.0318
Fe (wt%)	0.02	41.7	0.54	0.85	0.02	0.15	0.03	11.2
K (wt%)	0.04	<0.01	0.02	0.06	0.025	0.01	0.03	0.06
Li	<10	<10	<10	<10	<10	<10	<10	160
Mg (wt%)	25.4	3.46	0.225	11.8	0.105	0.05	0.025	1.56
Mn (wt%)	<0.005	1.25	43.2	0.06	<0.005	0.015	<0.005	0.825
Mo	<5	<5	<5	<5	<5	10	<5	<5
Na (wt%)	0.04	0.01	0.01	0.04	0.025	<0.01	<0.01	0.03
Ni	86	12	<2	8	2	12	<2	10
P (wt%)	<0.005	<0.005	0.02	<0.005	0.0075	<0.005	0.19	0.02
Pb	100	20	280	<10	<10	370	350	40
S	<50	1300	0.24 (wt%)	250	525	100	<50	6.99 (wt%)
Sc	<1	<1	2	<1	<1	19	<1	<1
Si (wt%)	0.345	1.21	1.35	0.12	0.0125	0.88	0.06	18.6
Sr	38	2	2	60	144	<2	<2	76
Ti (wt%)	<0.005	<0.005	<0.005	<0.005	<0.005	0.02	<0.005	0.01
V	<5	<5	<5	<5	<5	<5	20	10
Y	<10	<10	20	<10	<10	10	<10	<10
Zn	28	32	618	<2	<2	52	62	13.5 (wt%)
Zr	<20	<20	40	<20	<20	<20	<20	<20

**Table S2** Single carbonate CO<sub>2</sub> and weight loss data for thermal decomposition in O<sub>2</sub> carrier gas

LECO Total C (wt%)	CO <sub>2</sub> (wt%, total possible)	Temperature (°C)	Weight loss (wt%)	Generated CO <sub>2</sub> (% of total possible)
Calcite CaCO <sub>3</sub>				
11.3	41	400	0.80	1.9
		500	0.60	1.4
		600	2.40	5.7
		700	27.40	65
		800	44.20	105
Malachite Cu <sub>2</sub> (CO <sub>3</sub> )(OH) <sub>2</sub>				
4.2	16	400	28	100
		500	28	101
		600	28	102
		700	28	101
		800	29	104
Dolomite CaMg(CO <sub>3</sub> ) <sub>2</sub>				
13.1	48	400	0.00	0
		500	2.0	4
		600	4.0	8
		700	23	47
		800	47	98
Azurite Cu <sub>3</sub> (CO <sub>3</sub> ) <sub>2</sub> (OH) <sub>2</sub>				
5.30	19	400	30	99
		500	30	99
		600	30	97
		700	30	98
		800	30	98
Rhodochrosite MnCO <sub>3</sub>				
11.2	41	400	4	11
		500	12	30
		600	20	48
		700	30	73
		800	31	77
Magnesite MgCO <sub>3</sub>				
14.3	52	400	1.4	2.7
		450	3.0	5.7
		500	14	26
		550	41	79
		600	44	84
		700	51	97
		800	51	97

**Table S2** Continued.

LECO Total C (wt%)	CO <sub>2</sub> (wt%, total possible)	Temperature (°C)	Weight loss (wt%)	Generated CO <sub>2</sub> (% of total possible)
Ankerite Ca(Fe,Mg,Mn)(CO <sub>3</sub> ) <sub>2</sub>				
4.7	17	400	1.1	6.4
		500	5.8	34
		600	6.5	38
		700	6.7	39
		800	7.6	44
		900	9.9	58
		1000	12.7	74
Siderite FeCO <sub>3</sub>				
11.1	41	450	8.0	19
		500	21	53
		550	30	73
		600	32	79
		700	33	81
		800	33	81

**Table S3** CO and CO<sub>2</sub> emissions and weight loss for siderite thermal decomposition in O<sub>2</sub> carrier gas.

LECO Total C (wt%)	CO <sub>2</sub> (wt%, total possible)	Temperature (°C)	Weight loss (wt%)	Generated CO (% of total possible)	Generated CO <sub>2</sub> (% of total possible)	Generated CO + CO <sub>2</sub> (as CO <sub>2</sub> combined) <sup>4</sup>
<b>Siderite FeCO<sub>3</sub></b>						
11.1	41	450	9.3	0.00	23	23
		500	21	0.00	53	53
		550	30	0.05	73	73
		600	32	0.51	74	75
		700	32	0.68	78	79

**Table S4** CO and CO<sub>2</sub> emissions and weight loss for siderite thermal decomposition in N<sub>2</sub> carrier gas.

LECO Total C (wt%)	CO <sub>2</sub> (wt%, total possible)	Temperature (°C)	Weight loss (wt%)	Generated CO (% of total possible)	Generated CO <sub>2</sub> (% of total possible)	Generated CO + CO <sub>2</sub> (as CO <sub>2</sub> combined) <sup>4</sup>
Rhodochrosite MnCO <sub>3</sub>						
11.2	41	450	7.5	0.17	18	18
		500	17	0.13	43	43
		550	27	0.50	67	68
		600	34	0.34	82	83
		700	35	0.17	83	84
Magnesite MgCO <sub>3</sub>						
14.3	52	450	3.3	0.10	6.0	6.2
		500	12	0.47	22	23
		550	43	0.55	75	76
		600	44	0.63	81	82
		700	50	0.13	95	95
Siderite FeCO <sub>3</sub>						
11.1	41	450	24	2.2	56	59
		500	34	6.8	73	84
		550	35	12	66	85
		600	35	13	66	86
		700	36	5.4	78	86