

## DATA REPOSITORY. ANALYTICAL DETAILS AND RAW DATA

**Petrographic and mineralogical techniques.** Slabs 1 - 2 cm in thickness were cut from hand specimens, ground flat and polished on a vibrolap. After initial examination and photography, slab surfaces were etched in 5% HCl for 60 seconds. Stained acetate peels were prepared following treatment with acidified alizarin red-S and potassium ferricyanide (Miller, 1988). Based on peel and hand specimen fabrics, 70 polished thin sections were prepared for detailed petrographic examination. Cathodoluminescence (CL) was carried out using a CITL 8200 Mk2 cold-cathode luminoscope, operating at 10-15KV and a gun current of 200 - 300  $\mu$ A. Photoluminescence (PL) was carried out with a Nikon EF-D mercury fluorescence unit. Excitation and barrier filters were selected for blue incident light of  $\lambda = 560$  nm. The CL and PL equipment were both mounted on a Nikon Optiphot microscope and photographs taken using 400 ASA Fujicolour print film. Some polished thin sections were stained on their lower surfaces prior to mounting, to allow direct comparison of CL / PL and compositional patterns. Back-scatter scanning electron microscopy (BSEM) was performed on carbon-coated polished thin sections, using an ISI ABT55 instrument at Aberdeen University. X-ray diffraction analyses were performed on unoriented powder mounts, using Ni-filtered Cu  $\alpha$  radiation in a Siemens D-500 diffractometer, a scan speed of  $2^\circ 2\theta$  per minute and a step size of  $0.05^\circ$ . Traces were plotted on a continuous chart recorder running at 2.0 cm per minute.

**Stable isotopes in calcite and dolomite.** Between 2 - 3 mg powdered carbonate was treated for at least 4 hours in a low-temperature plasma asher to remove organic contaminants, and then reacted overnight with 100%  $\text{H}_3\text{PO}_4$  *in vacuo* (calcites at  $25^\circ\text{C}$ , dolomites at  $50^\circ\text{C}$ ). The  $\text{CO}_2$  produced was purified in a cryogenic trap and then analysed for C and O isotope ratios on a VG SIRA12 mass spectrometer at Liverpool University. A laboratory standard calibrated against NBS-19 (Liverpool LL2) was run after every 4 to 6 samples. Raw data were corrected using an acid fractionation factor ( $\alpha$ ) of 1.01025 for calcite at  $25^\circ\text{C}$  (Friedman & O'Neil, 1977) and 1.01066 for dolomite at  $50^\circ\text{C}$  (Rosenbaum & Sheppard, 1986). Analytical precision (at 95% confidence level) based on duplicate "unknown" samples was better than 0.06‰ for both  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$ .

**Stable isotopes in barite and celestite.** Samples of 20 - 50 mg were dissolved in a 2%  $\text{Na}_2\text{CO}_3$  solution which was kept at low pH to remove any residual carbonate, following the procedure described by Longinelli & Cortecci (1970). The solution was then filtered and

mixed with  $\text{BaCl}_2$  (aq) to cause precipitation of  $\text{BaSO}_4$ . Approximately 15 mg of  $\text{BaSO}_4$  was mixed with graphite and heated to  $1100^\circ\text{C}$  *in vacuo* to produce  $\text{CO}_2$  for  $\delta^{18}\text{O}$  determination (Longinelli & Craig, 1967). BaS produced in this reaction was treated with 0.1N  $\text{AgNO}_3$  solution to precipitate  $\text{Ag}_2\text{S}$  for  $\delta^{34}\text{S}$  analysis after oxidation with pure oxygen to form  $\text{SO}_2$  (Filly *et al.*, 1975).  $\text{CO}_2$  and  $\text{SO}_2$  gas samples were analysed in a VG SIRA 9 mass spectrometer at Université Pierre et Marie Curie in Paris. Precisions based on duplicate analyses of an internal sulphate standard and unknowns were better than 0.1‰ for both  $\delta^{18}\text{O}$  and  $\delta^{34}\text{S}$ .

**Trace elements in carbonates.** Pure carbonate samples of between 5.0 - 10.0 mg were completely dissolved in 5% reagent-grade HCl, and analysed in a multichannel Thermo Jarrell Ash Polyscan 61E ICP-AES instrument at the Servei d'Espectroscòpia at Barcelona University. The spectral wavelength for each analysed element was as follows: Sr, 421.55 nm; Mn, 257.61 nm; Fe, 259.94 nm; Mg, 279.08 nm; Ba, 455.40 nm. Matrix-matched, synthetic standards were used for calibration. Analytical errors were < 10% for trace elements and < 5% for major elements.

**Fluid inclusions.** Primary inclusions with no evidence for stretching or necking were selected and measurements were carried out on a Linkam THM600 stage fitted to a Nikon Optiphot II-POL microscope. Ramp rate was set to  $10^\circ$  per minute up to  $100^\circ\text{C}$  and  $1^\circ$  intervals to homogenization point. Final resolution of homogenization temperature was carried out at  $0.1^\circ$  per minute ramp rate. Although sampling was directed towards saddle dolomite, a lesser number of calcite inclusions was also examined. Freezing measurements could not be accurately carried out in dolomite or calcite owing to the small size of unstretched inclusions.

TABLE DR1: CARBONATE ISOTOPIC AND GEOCHEMICAL DATA

Sample type	Sample number	Position (m from base)	$\delta^{13}\text{C}$ (‰ PDB)	$\delta^{18}\text{O}$ (‰ PDB)	Ca (wt %)	Mg (ppm)	Fe (ppm)	Mn (ppm)	Sr (ppm)	Ba (ppm)
<u>Calcite</u>										
C1	CA2	1.2	0.2	-7.5	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C1	CA6	10.2	0.4	-8.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C1	CA9	10.5	0.0	-6.8	38.79	5300	193	70	1211	13
C1	CA37	12.1	0.2	-7.0	37.55	3300	150	106	686	5
C1	CA38	19.5	-0.6	-8.2	37.50	4000	87	146	1268	5
C1	CA17	23.8	-0.2	-7.3	38.41	3200	100	95	1709	17
C1	CA39	26.4	0.0	-7.9	37.73	3600	115	127	1916	6
C1	CA22	26.6	-0.1	-8.0	38.37	5100	595	160	1609	54
C1	CA40	29.0	0.0	-8.1	38.31	4700	211	90	1726	12
C1	CA47	30.2	-0.8	-8.5	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C1	CA28	33.1	0.5	-7.8	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C1	CA30	38.3	0.3	-8.1	39.36	4400	186	77	2018	705
C1	CA31	42.8	0.0	-7.8	37.91	4100	124	64	2455	4
C1	CA54	47.8	-0.3	-7.5	37.71	3500	121	106	2359	15
C1	CA56	49.9	-0.4	-7.2	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C2	CA6	10.2	0.2	-8.3	38.06	3800	88	88	1176	29
C2	CA17	23.8	0.0	-8.8	39.49	3400	190	111	752	20
C2	CA20	26.3	0.0	-8.6	38.93	2471	114	113	600	16
C2	CA40	29.0	-0.5	-8.9	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C2	CA47	30.2	-0.4	-8.9	38.34	3900	233	116	457	13
C2	CA31	42.8	-0.1	-8.6	38.39	2900	39	86	901	9
C3	CA9	10.5	-0.1	-7.2	39.46	3700	75	226	75	11
C3	CA36	11.5	-0.3	-7.1	38.96	3300	88	206	59	181
C3	CA38	19.5	-0.7	-6.7	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C3	CA38	19.5	-1.0	-7.5	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C3	CA17	23.8	-0.3	-6.6	38.82	2800	73	164	107	5
C3	CA17	23.8	-0.4	-7.1	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C3	CA22	26.6	-0.7	-7.0	38.84	2715	492	188	134	1
C3	CA21	26.8	-0.5	-7.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C3	CA30	38.3	0.4	-6.4	38.81	2700	48	120	102	24
C3	CA54	47.8	-0.6	-7.0	38.52	2600	322	370	275	24
C3	CA41	49.5	-0.5	-7.1	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C3	CA56	49.9	-0.6	-6.2	39.39	2691	285	194	352	12
C4	CA1	0.5	-0.1	-8.5	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C4	CA2	1.2	0.2	-8.0	39.58	3211	2684	1632	279	0
C4	CA4	6.1	0.3	-7.9	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C4	CA6	10.2	0.2	-7.8	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C4	CA9	10.5	-0.3	-7.6	39.42	3400	331	187	82	109
C4	CA33	10.8	0.0	-8.4	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C4	CA39	26.4	-0.6	-8.1	39.39	4837	2050	281	248	502
C4	CA39	26.4	-0.9	-7.7	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

C4	CA39	26.4	-0.7	-8.2	40.56	5022	1911	267	289	6444*
C4	CA40	29.0	-0.7	-7.4	38.09	2700	464	187	93	424
C4	CA47	30.2	-1.0	-8.2	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C4	CA47	30.2	-0.5	-8.2	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C4	CA28	33.1	0.0	-8.2	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C4	CA30	38.3	0.2	-7.8	39.17	4700	1000	157	203	345
C4	CA31	42.8	-0.1	-8.2	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C4	CA31	42.8	0.0	-8.6	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C4	CA54	47.8	-0.5	-7.7	39.56	4200	1117	489	383	213
C4	CA56	49.9	-0.5	-7.6	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C4	CA41	49.5	-0.6	-8.1	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C4	CA43	49.5	-0.9	-7.8	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C5	CA5	7.6	-1.1	-9.7	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C5	CA6	10.2	0.0	-9.4	26.88	1900	493	85	4627	20408*
C5	CA39	26.4	-2.1	-8.8	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C5	CA69	28.1	-1.4	-8.6	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C5	CA28	33.1	-2.0	-9.4	38.99	2100	149	153	1015	26
C5	CA61	50.1	-1.8	-8.9	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
C5	CA41	49.5	-1.4	-7.9	38.60	2600	792	142	943	311

Microspar in borings

MS	CA37	12.1	0.0	-4.8	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
MS	CA14	17.4	-0.8	-8.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
MS	CA64	17.5	-1.3	-4.9	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
MS	CA19	23.4	-0.2	-7.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
MS	CA54	47.8	0.0	-7.7	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
MS	CA56	49.9	-0.2	-7.2	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
MS	CA57	50.9	-0.5	-8.1	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dolomite

D2	CA6	10.2	0.4	-8.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
D2	CA33	10.8	-0.1	-7.2	25.97	4.25	1.11	295	223	108
D2	CA19	23.4	0.0	-7.9	24.15	9.10	1.84	426	112	42
D2	CA39	26.4	0.0	-7.8	24.20	10.74	2.44	0	180	17
D2	CA39	26.4	0.0	-7.8	25.21	10.38	2.39	661	166	86
D2	CA22	26.6	0.1	-7.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
D2	CA21	26.8	-0.2	-8.1	23.56	10.96	2.40	0	152	22
D2	CA69	28.1	0.0	-7.5	23.29	10.23	2.33	0	500	445
D2	CA40	29.0	0.2	-7.7	24.36	13.31	2.38	0	175	68

Oysters

SBX1	2.1	-3.6	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
SBX2	1.8	-3.1	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
FE11	2.5	-2.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
FE49	2.6	-2.4	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

\* Contaminated by barite.

TABLE DR2: SULFATE ISOTOPIC DATA

Sample type	Sample number	Position (m from base)	$\delta^{34}\text{S}$ (‰ CDT)	$\delta^{18}\text{O}$ (‰ PDB)
Barite	CA6	10.2	35.0	17.9
Barite	CA6	10.2	30.1	17.2
Barite	CA17	24.8	24.9	16.6
Barite	CA69	28.1	36.0	17.4
Barite	CA72	above reef	24.1	18.6
Celestite	CA43	49.5	20.0	16.0