Supplementary Materials

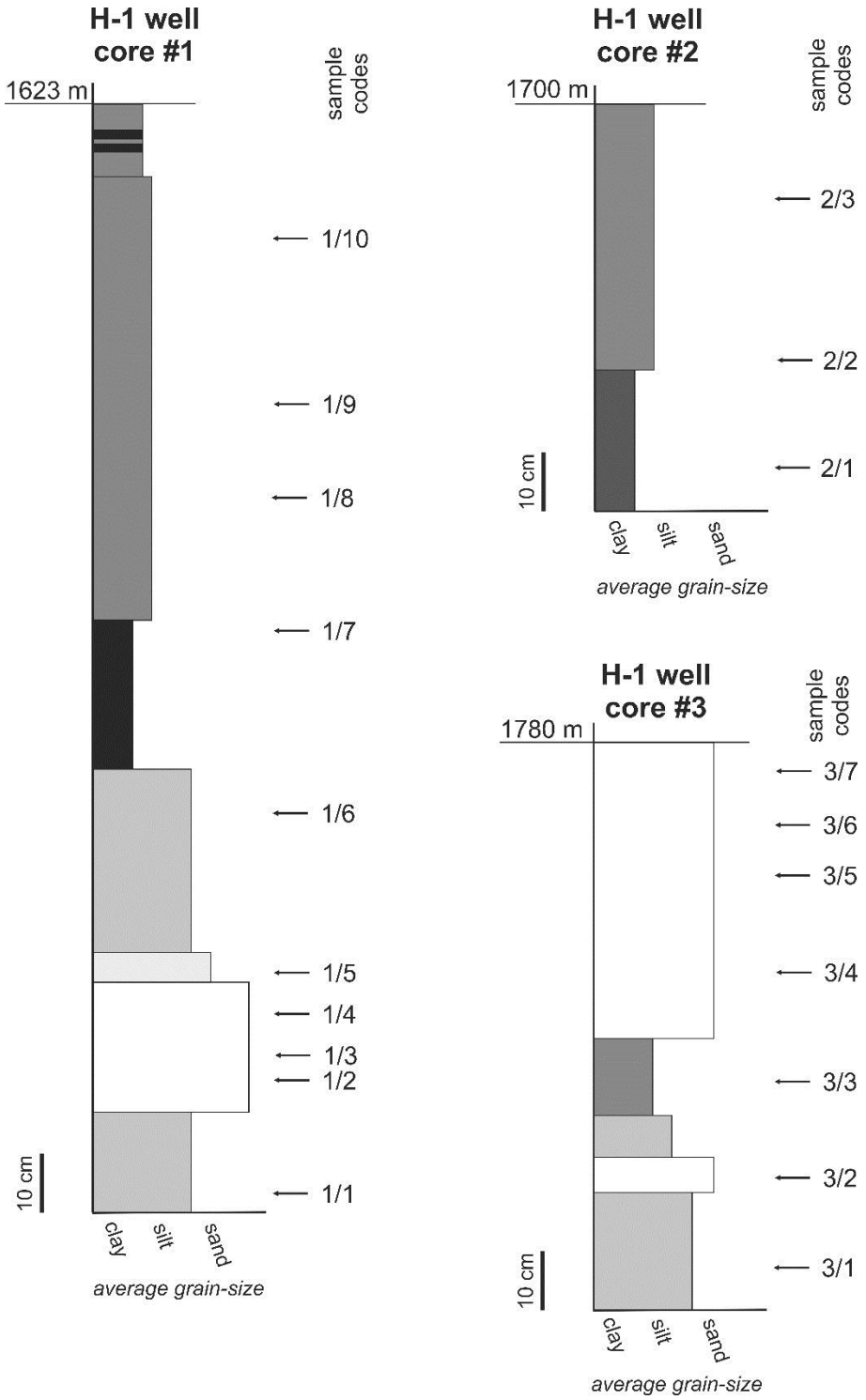

Figure S1: Schematic lithologic logs of the investigated core sections (well H–1, Szeged, Hungary), showing the position of the studied samples.

Figure S2: Typical lithologic characters of the analyzed core sections (core diameter: 76 mm). (a) Alternating fine-grained sandstones and siltstones with disseminated pyrite (brown spots), core #3. (b) Alternating very fine-grained sandstones and mudrocks, core #3. (c) Coal-bearing claystones, core #1.

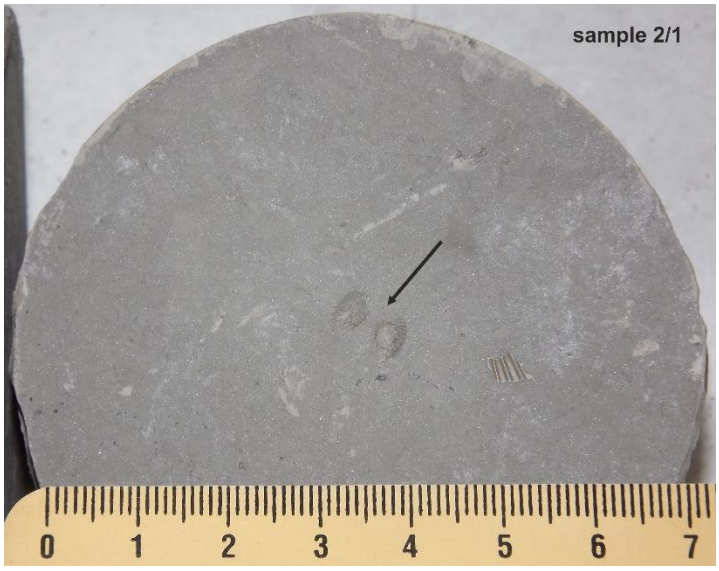

Figure S3: Bivalve shells in a clayey marl sample, core #2. *Note*: the presence of thin shells of *Paradacna abichi* (arrow) reflects a delta slope depositional facies.

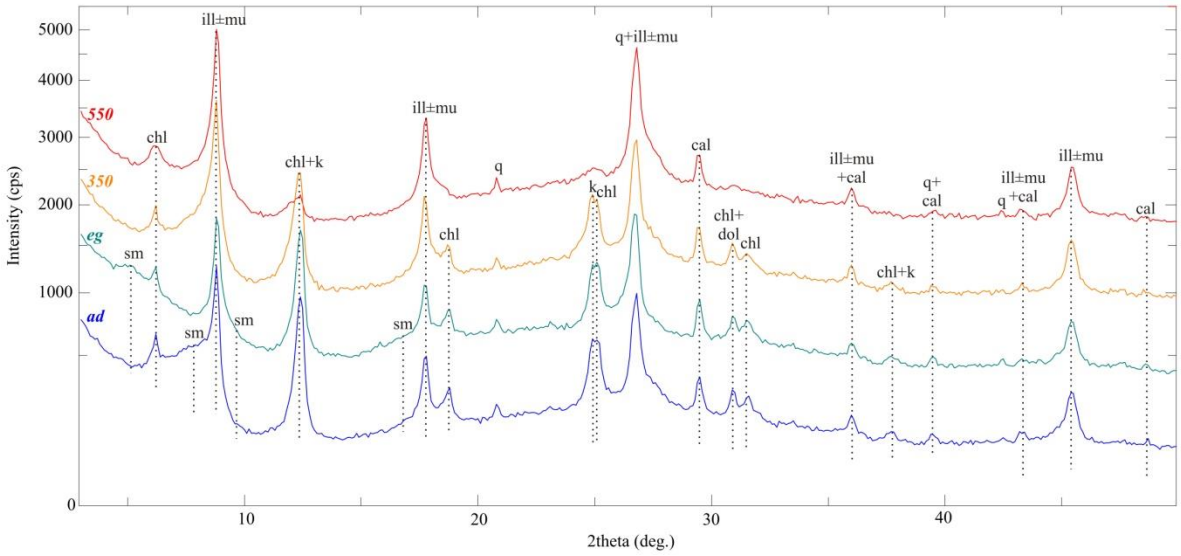

Figure S4: Typical XRPD patterns (<2 µm fraction, highly oriented mount) of the studied core samples (sample 1/8). Abbreviations: ad: air-dry; eg: ethylene-glycol solvated; 350: heat-treated at 350°C; 550: heat-treated at 550°C; cal: calcite; chl: chlorite; dol: dolomite; ill±mu: illite±muscovite; k: kaolinite; q: quartz; sm: smectite±highly swelling mixed-layer illite/smectite.

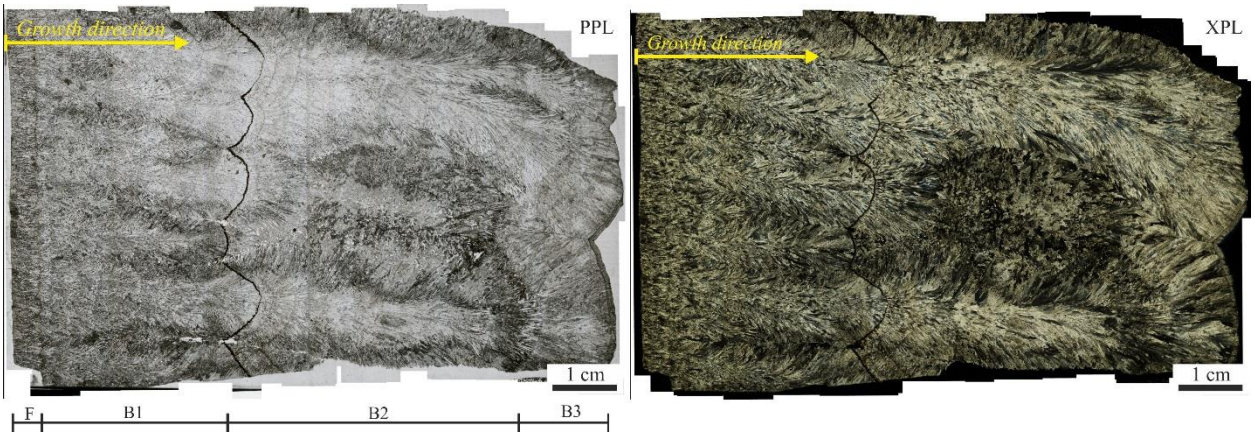

Figure S5: Scanned overview images of a thin-section prepared from the thick calcite scale (inner part of the sample G-03), showing a complex morphology with fibrous (F) to botryoidal (B1 to B3) zones. *Note:* B1/B2 boundary (an intermittent brownish stained layer) separates seasonal (annual) operational rhythms. Fine lamination represents effects related to the periodical (weekly or daily) operation phases. The growth direction is marked by a yellow arrow. Abbreviations: PPL = plane polarized light; XPL = crossed polars.

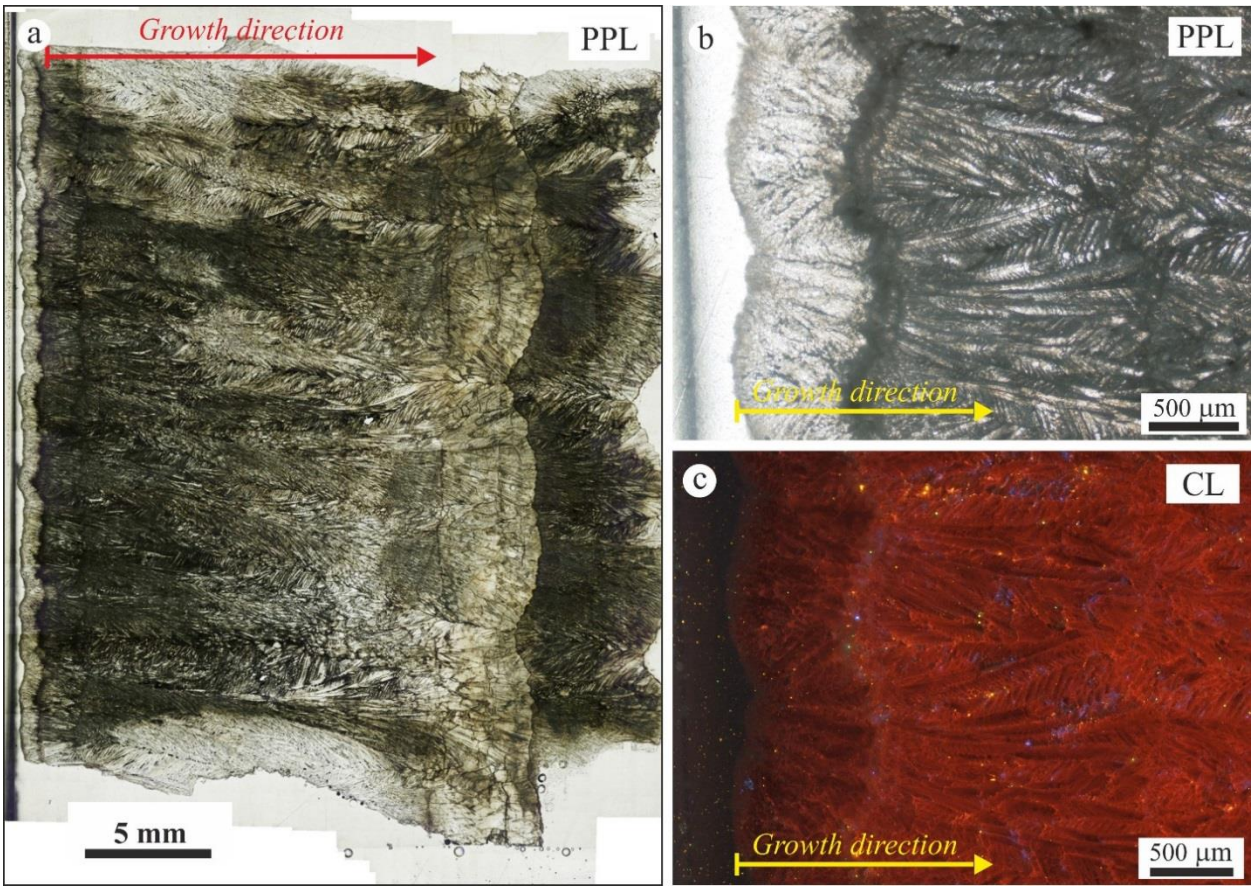

Figure S6: The studied annual scale sample (sample G-10) from the downtown geothermal cascade system sampled from a pipe between the production well and the buffer tank. (a) The calcite scale shows complex microscopic zonation of highly variable thicknesses. (b) and (c) Limpid, fibrous growth zone followed by a later zone composed of turbid dendritic skeletal crystals. Note that the carbonate precipitation began with the thin, limpid, non-luminescent lamina (left), and was followed by a thick, luminescent and more porous lamina with siliciclastic contamination (right). Abbreviations: PPL = plane polarized light; CL = cathodoluminescence.

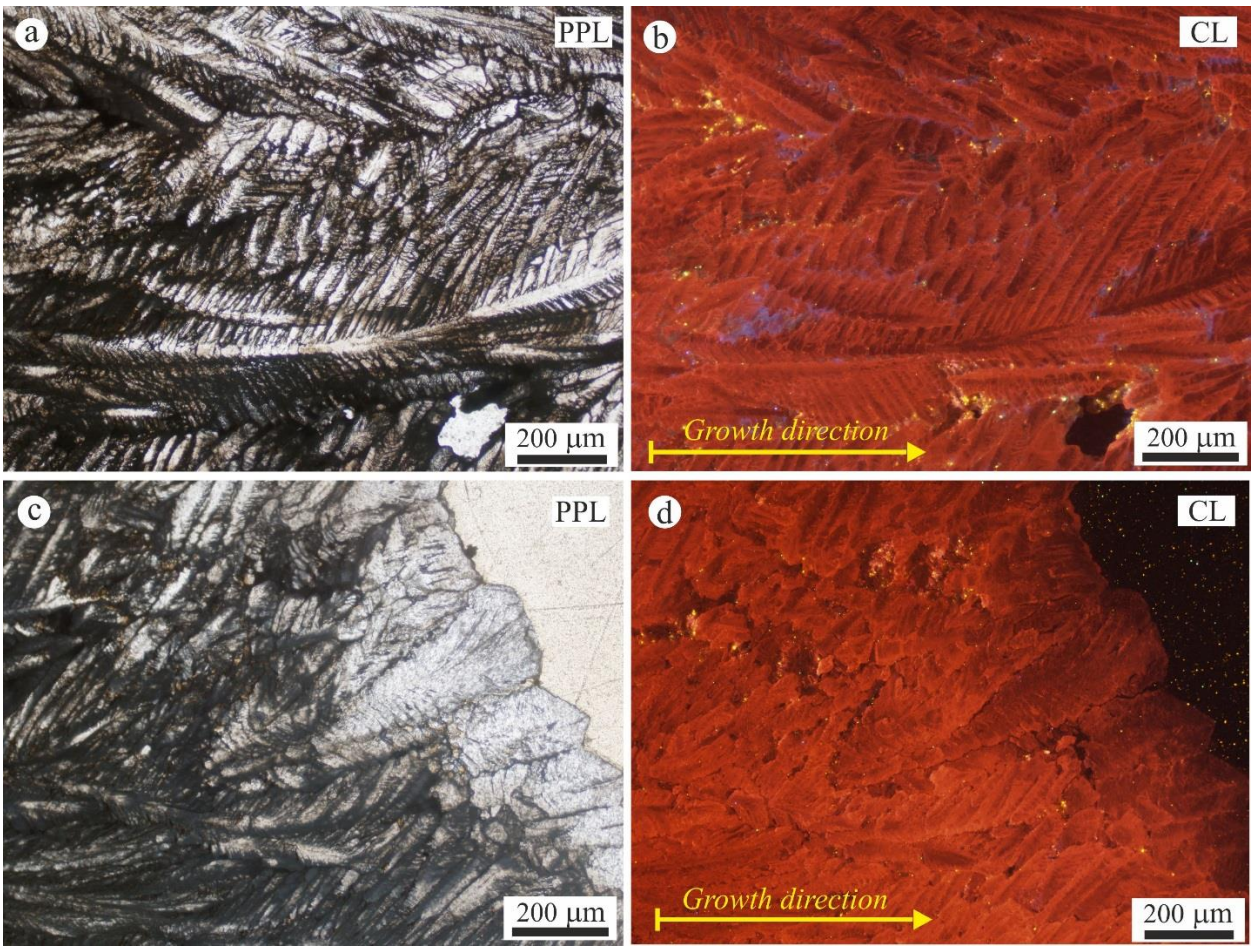

Figure S7: Dendritic crystal growth during scale formation (sample G-10, downtown system). (a) and (b) Feather-like dendrites characterized by multiple level of branching. (c) and (d) Contact of a turbid zone, made up of dendritic crystals with bright CL and a limpid, tightly packed zone with dull luminescence. Abbreviations: PPL = plane polarized light; CL = cathodoluminescence.

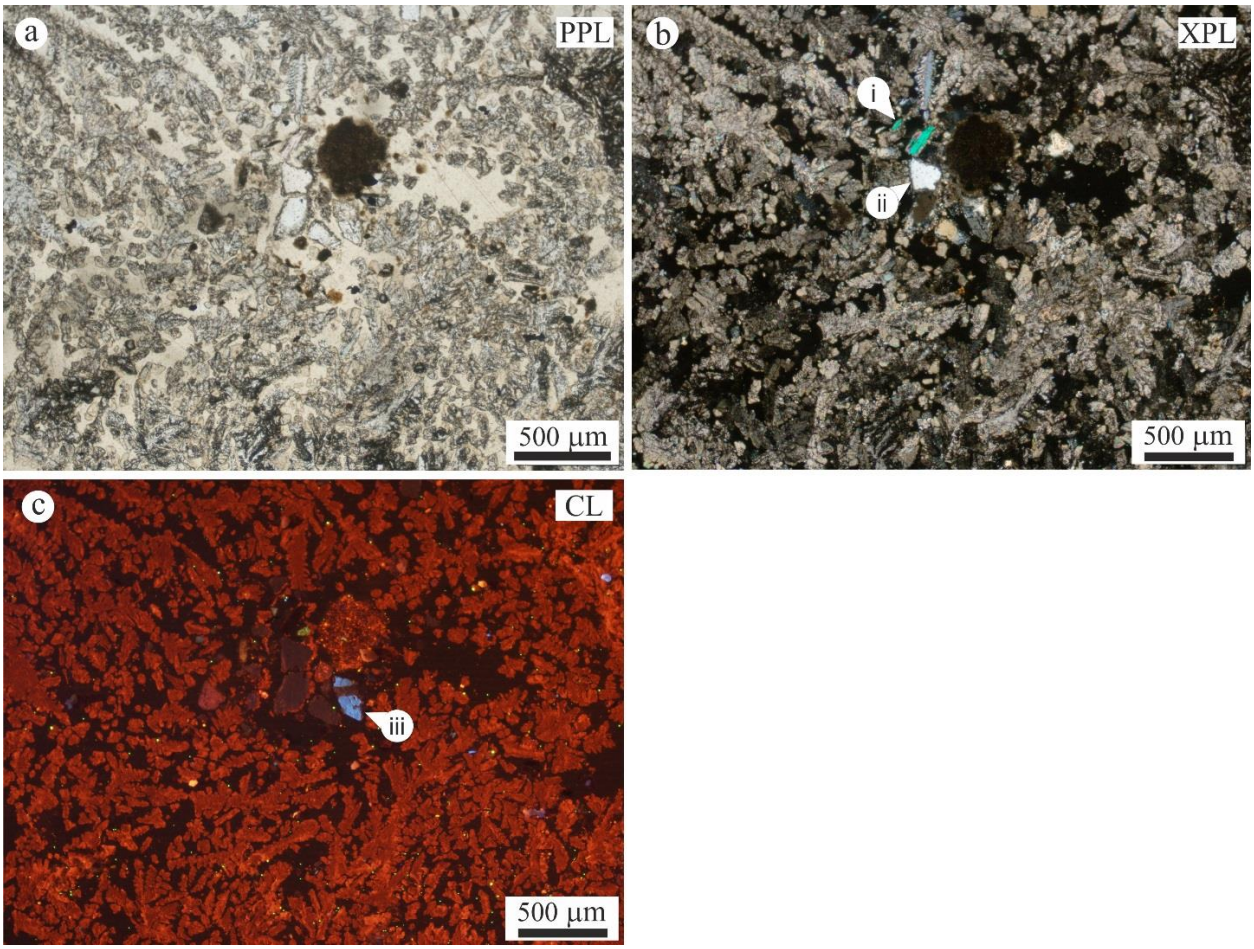

Figure S8: Detrital minerals in the porous scale (sample G-03, B2 zone): muscovite (i), quartz (ii), and feldspar (iii). Abbreviations: PPL = plane polarized light; XPL = crossed polars; CL = cathodoluminescence.

Table S1: Mineralogical composition of the studied bulk rock samples and separated clay fractions. Abbreviations: 14A = 14 Ångström phase (chlorite±vermiculite±smectite); 10A = 10 Ångström phase (illite±mica); 7A = 7 Ångström phase (kaolinite); cal = calcite; chl = chlorite; dol = dolomite; sm = smectite±highly swelling mixed-layer illite/smectite; k: kaolinite; kf: = K-feldspar; pl = plagioclase feldspar; pyr = pyrite; q = quartz; tr = trace amount.

Sample code	Lithology	Bulk sample (~mass%)	Clay fraction (~mass%)
1/1	fine-grained sandstone, siltstone, and clayey marl	q (40–50), 10A (10–20), dol (10–20), cal (5–10), 14A (5–10), kf (tr), pl (tr), 7A (tr)	10A (50–60), chl (20–30), k (5–10%), sm (tr), q (tr), cal (tr), dol (tr)
1/6	fine-grained sandstone, siltstone, and clayey marl	q (40–50), 10A (10–20), dol (10–20), cal (5–10), 14A (5–10), kf (tr), pl (tr), 7A (tr)	10A (60–70), chl (20–30), k (5–10%), sm (tr), q (tr), cal (tr), dol (tr)
1/7	coal-bearing shale	10A (40–50), q (20–30), 7A (10–20), dol (5–10), 14A (5–10), cal (tr), kf (tr), pl (tr), pyr (tr)	10A (70–80), chl (10–20), k (5–10%), sm (5–10%), q (tr), cal (tr), dol (tr)
1/8	bioturbated clayey marl	q (30–40), 10A (20–30), 14A (10–20), dol (10–20), cal (5–10), kf (tr), pl (tr), 7A (tr)	10A (50–60), chl (20–30), k (10–20), sm (5–10%), q (tr), cal (tr), dol (tr)
2/1	clayey marl with mollusc shells	q (30–40), dol (20–30), 10A (10–20), 14A (10–20), cal (5–10), kf (tr), pl (tr), 7A (tr)	10A (60–70), chl (10–20), k (5–10%), sm (5–10%), q (tr), cal (tr), dol (tr)
2/2	dolomitic marl with mollusc shells	q (40–50), dol (20–30), cal (10–20), 10A (5–10), 14A (tr), kf (tr), pl (tr), 7A (tr)	10A (60–70), chl (20–30), k (5–10%), sm (tr), q (tr), cal (tr), dol (tr), pyr (tr)
2/3	silty clayey marl	q (30–40), 10A (20–30), dol (10–20), pl (10–20), cal (5–10), 14A (tr), kf (tr), 7A (tr)	10A (40–50), chl (30–40), k (5–10%), sm (tr), q (tr), cal (tr), dol (tr)
3/2	claystone and shale with cross-laminated fine-grained sandstone and siltstone intercalations	10A (50–60), q (20–30), dol (5–10), 14A (5–10), pl (5–10), cal (tr), kf (tr), 7A (tr)	10A (60–70), chl (20–30), k (5–10%), sm (5–10%), q (tr), cal (tr), dol (tr)
3/3	bioturbated siltstone and claystone	10A (50–60), q (20–30), pl (10–20), dol (5–10), 14A (5–10), cal (tr), kf (tr), 7A (tr)	10A (40–50), chl (30–40), k (10–20), sm (tr), q (tr), cal (tr), dol (tr), pyr (tr)
3/7	cross-bedded sandstone and siltstone with pyritic patches	q (30–40), 10A (30–40), dol (5–10), cal (5–10), pl (5–10), 14A (tr), kf (tr), 7A (tr)	chl (50–60), 10A (30–40), k (5–10%), sm (tr), q (tr), cal (tr), dol (tr)

Table S2: Measured d_{104} values and estimated composition of calcite and dolomite of the studied bulk rock samples.

Sample code	d_{104} values and estimated mole % of $MgCO_3$ in calcite	d_{104} values and estimated mole % of $MgCO_3$ in dolomite
1/1	3.034 Å ≈ 1	2.893 Å ≈ 48
1/6	3.028 Å ≈ 3	2.885 Å ≈ 52
1/7	3.038 Å ≈ 0	2.890 Å ≈ 50
1/8	3.034 Å ≈ 1	2.884 Å ≈ 52
2/1	3.030 Å ≈ 2	2.886 Å ≈ 51
2/2	3.033 Å ≈ 1	2.887 Å ≈ 51
2/3	3.034 Å ≈ 1	2.891 Å ≈ 50
3/2	3.032 Å ≈ 1	2.889 Å ≈ 50
3/3	3.033 Å ≈ 1	2.889 Å ≈ 50
3/7	3.031 Å ≈ 2	2.890 Å ≈ 50