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Supplemental Material

Text. Description of the columnar sections

Table A1. Location of the sections and $^{87}\text{Sr}/^{86}\text{Sr}$ samples studied in the current research.

Table A2. Mineralogical composition of the studied samples.

Table A3. Chemical composition of the studied samples.

Figures S1–S8. Description of the stratigraphic sections.

Figure S1. Lithostratigraphy of the Hurvat Ze'ev Section (HZ). The top of the section is at coordinates 32° 38' 24" N, 35° 28' 48" E and elevation 110 msl (meters above sea level). For legend, see Figure S10.

Figure S2. Lithostratigraphy of the Nahal Hamud Composite Section (NH-1; NH-5). The top of the section is at coordinates 32° 37' 02" N, 35° 27' 41" E and elevation 110 msl (meters above sea level). Red dots indicate samples of the NH-5 section. For legend, see Figure S10.

Figure S3. Lithostratigraphy of the Nahal Hagal Section (GG). The top of the section is at coordinates 32° 38' 35" N, 35° 32' 32" E and elevation 10 msl (meters above sea level). For legend, see Figure S10.

Figure S4. Lithostratigraphy of the Teverya Lower Section (TV-1). The top of the section is at coordinates 32° 47' 58" N, 35° 31' 52" E and elevation –145 msl (meters above sea level). For legend, see Figure S10.

Figure S5. Lithostratigraphy of the Teverya Upper Section (TV2/3). The top of the section is at coordinates 32° 48' 12" N, 35° 31' 20" E and elevation –88 msl (meters above sea level). For legend, see Figure S10.

Figure S6. Lithostratigraphy of the Migdal HaEmeq Section (MH). The top of the section is at coordinates 32° 40' 26" N, 35° 15' 30" E and elevation 300 msl (meters above sea level). For legend see Figure S10.

Figure S7. Lithostratigraphy of the Kokhav HaYarden Section (KH). The top of the section is at coordinates 32° 34' 58" N, 35° 31' 25" E and elevation 230 msl (meters above sea level). For legend, see Figure S10.

Figure S8. Lithostratigraphy of the Zemah-1 borehole (Z-1). ($^{87}\text{Sr}/^{86}\text{Sr}$ data of Raab et al., 1997). The top of the section is at coordinates 32° 41' 23" N, 35° 35' 51" E and elevation –192 msl (meters above sea level). For legend, see Figure S10.

Figure S9. Lithostratigraphy of the Tula Quarry Section (GQ). The top of the section is at coordinates 32° 38' 41" N, 35° 32' 45" E and elevation –47 msl (meters above sea level). For legend, see Figure S10.

Figure S10. Legend indicates the lithology and structure symbols noted in all columnar sections of repository data figures S1 to S9

Figure S11. Lateral W-E schematic cross section in the northern valleys.

Plate 1. Photomicrographs and Scanning Electron Microscope images of the carbonate textures from the Bira and Gesher Formations. D- dolomite; Ca- calcite; Cl⁻ clay; (A-B) Sample DS-7 of Dolomitic mudstone from the Bira Formation. Dolomite crystals are mostly subhedral, smaller than ~7 µm and closely associated with clays. (C-D) Sample DS-10 of Calcitic gastropod floatstone with an argillaceous wackstone matrix from the Bira Formation. Intraclasts size vary between sand and gravel. Pellets are common (blue arrows) and calcite microsparite crystals mostly appear as drusy texture (red arrows) in porous or dissolved areas. (E-F) Sample DS-62 of mudstone with micrite grains from the Gesher Formation. Calcite crystals show sparry and sharp texture and are closely associated with clays. (G-H) Sample DS-66 of dolomitic mudstone from the Gesher Formation. Dolomite crystals are subhedral, smaller than ~7 µm and closely associated with clays.

Plate 2. Selected images of gypsum sediments from the Bira Formation (for description of Subfacies see Rozenbaum et al., 2019). (A) (Subfacies B3c). Alternations of selenite gypsum and laminated gypsum. Tula Quarry. (B) (Subfacies B3c). Selenite gypsum texture on the top of the Bira Formation on the Hagal Steam section.

DESCRIPTION OF THE COLUMNAR SECTIONS

Migdal HaEmeq Section (MH)

Migdal HaEmeq (MH) section is the thickest known exposure of the Bira and Gesher Formations in the western side of the Northern Valleys (Fig. 2). It comprehends the Lower Basalt Unit, the Red Clays Unit, the Bira and the Gesher Formations (Fig. S6). The Cover Basalt Unit is identified in a few exposures near the section. The Bira Formation has a thickness of 42 m and consists of well bedded soft limestones and dolomitic limestone with pyroclastic grains and bentonite nodules, which build the middle and upper parts of the Formation. A thin bed on the lower part of the section contains marine mollusks (Rozenbaum et al., 2019). The contact with the Gesher Formation is a paraconformity, which bounds the Bira Formation top integrated by 8 m of limestones beds with marine and freshwater macrofauna probably correlative with the lumachelle bed. Gesher Formation has a thickness of ~30 m and comprises limestone beds of the lower [(G1a), middle (G1b) and upper (G1c) parts. These “parts” are sub-lithofacies according to Rozenbaum et al., (2019).

Nahal Hamud Sections (NH-1, NH-5)

Two sections were studied in this area, both located on the southern margins of the Hamud stream, one of the tributaries of the Tavor stream on the Lower Galilee (Fig. 2). The eastern section (NH-1) (Fig. S2) exposed the uppermost 5 m of the Bira Formation, which is mainly dolomitic and contains in the upper meter marine bivalve, gastropods and fish scales (Levi, Z. pers. comm., 2014) possibly correlative with the lumachelle bed. The contact with the Gesher Formation is a paraconformity. The overlying Gesher Formation is 42 m thick and comprises limestones, calcareous dolostones and dolostone beds of the lower (G1a), middle (G1b) and upper (G1c) “parts”. The Gesher Formation is overlain by 8 m of conglomerates, paleosols and pyroclastic rocks equivalent to the Fejjas Tuff Unit. On the top of the section the Cover Basalt Unit builds a plateau to the south. The western section (NH-5) presents limestones and calcareous dolostones beds of the middle and upper parts of the Gesher Formation. The top of the Formation exposes 0.7 m of limestone with marine macrofauna. The Gesher Formation has a thickness of ~48 m and is overlain by the Cover Basalt Unit.

Hurvat Ze'ev Section (HZ-1)

Located on a small tributary of the Tavor Stream (Fig. 2), the Hurvat Ze'ev section represents the main sampling site of this research. This section possibly displays the whole section of the Bira and the Gesher formations on the Northern Basins. The section includes the upper part of the Lower Basalt, the Umm Sabune, the Bira and the Gesher Formations and an alluvial thin unit at the top (Fig. S1); the Cover Basalt is exposed ~200 m east of the top of the section (Rozenbaum et al., 2016). The Bira Formation is 60 m thick and principally comprises alternations of laminated to well bedded limestones, dolomitic limestones, calcareous dolostones and dolostones. Beds and lenses of bentonite are interbedded with carbonate rocks along the formation. Most beds contain pyroclastic fragments and macrofauna.

Five beds of carbonate contain marine mollusks (Shaked-Gelband, 2020); the lowest is gradually overlying the Umm Sabune Formation and the upper is the lumachelle bed that is

underlying the Gesher Formation. Other beds contain freshwater fauna, mainly gastropods (Shaked-Gelband et al., 2012). The contact with the Gesher Formation is not exposed. The Gesher Formation is ~46 m thick and consists of alternation of dolostones, calcareous dolostones and limestones with lenses and beds of bentonites on the lower (G1a), middle (G1b) and upper (G1c) “parts”. Bivalve marine fauna is identified on the base of the member g2.

Hagal Stream Section (GG-3)

This section is exposed along the Hagal Stream, a tributary of the Jordan River, located in the western margins of the Jordan Valley (Fig. 2) and includes the middle and upper part of the Bira Formation, the Gesher Formation and the Cover Basalt Unit (Fig. S3). The exposed Bira Formation is 32 m thick and consists of alternations of gypsum beds, dolostones and limestones with gypsum nodules, overlain by 7 m of selenite gypsum (see Plate 2). The contact with the Gesher Formation is apparently a paraconformity. The overlying Gesher Formation is 38 m thick and comprises dolostones, limestones and marls beds of the lower (G1a), middle (G1b) and upper “parts” (G1c).

Tula Quarry (GQ-1)

The Tula gypsum quarry is located along the Tula Stream, a tributary of the Jordan River, located in the western margins of the Jordan Valley (Fig. 2). The quarry is currently a landfill where only the top of the Bira Formation and the lower and middle parts of the Gesher Formation are exposed. The Bira formation is ~2.5 m thick and consists of vertical selenite gypsum with laminated gypsum. The contact with the Gesher Formation is a disconformity. The Gesher Formation is ~26 m thick and consists of alternations of dolostones, calcareous dolostones, dolomitic limestones and limestones. An alluvium unit covers the top of the sequence (Fig. S9).

Teverya Sections (TV1–2–3)

These sections are located along a tectonic escarpment on the western margins of the Sea of Galilee (Fig. 2), where Bira and Gesher Formations are exposed. Two [1–2-3] sections were sampled (Fig. S4 and S5). Combining the two sections the Bira Formation is ~31 m thick and represents at least its middle and upper part. The Bira Formation consists of dolostones alternated with calcareous dolostones, dolomitic limestones, limestones and marls with bentonite beds and nodules, and pyroclastic grains. The Gesher Formation (Fig. S5) is ~29 m thick and comprehends dolostones, calcareous dolostones and marls with beds and nodules of bentonite of the lower (G1a), middle (G1b) and upper (G1c) “parts”. A bed with marine and freshwater macrofauna is located in the middle part G1b (Levy, pers. comm., 2016). The Cover Basalt Unit overlies the Gesher Formation and forms a plateau on the top of the section.

Kokhav HaYarden (KH-1)

This section is exposed along a 450 m high tectonic escarpment on the western margins of the Jordan Valley (Fig. 2). The section includes the upper part of the Lower Basalt, a thick Umm Sabune Formation, the Bira Formation and the Cover Basalt Unit (Fig. S7). The uppermost

part of the Lower Basalt at the base of the section is well-exposed due to past quarrying. The overlying Umm Sabune Formation is 130 m thick and mainly comprises graded bedded fluvial sediments with coarse basalt clasts and pyroclastic matrix. A basalt flow intercalates with the fluvial sediment in the lower part of the formation.

The Bira Formation has thickness of ~130 m and is dominated by well-bedded carbonates, mainly dolostones, and calcareous dolomites with some marl and calcareous clays, the latter include thin (3–5 cm) paleosols. Two basalt flows appear in the lower part of Bira between the sediments. The Gesher Formation is missing in this section either due to erosion or to non-deposition. The overlying Cover Basalt builds a prominent 20–30 m thick cliff at the top of the escarpment.

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TABLE A1. LOCATION OF THE SECTIONS AND $^{87}\text{Sr}/^{86}\text{Sr}$ SAMPLES STUDIED IN THE CURRENT RESEARCH

Serial N°	Location	Symbol	Coordinates		Section (m.s.l.)	$^{87}\text{Sr}/^{86}\text{Sr}$ Samples	Figure
			North	East			
	Nesher	N	32° 45' 35"	35° 03' 39"	5	6	
	Tel Qashish	TQ	32° 41' 05"	35° 06' 34"	35	1	
1	Newe Ya'ar	NwY	32° 42' 20"	35° 10' 59"	80	1	
2	Migdal HaEmeq	MH	32° 40' 26"	35° 15' 30"	300	10	S-6
3	Hamud Stream-5	NH-5	32° 37' 07"	35° 27' 23"	115	3	
4	Hamud Stream-1	NH-1	32° 37' 02"	35° 27' 41"	110	10	S-2
5	Hurvat Ze'ev	HZ	32° 38' 24"	35° 28' 48"	110	22	S-1
6	Ramat Sirin	RS	32° 38' 42"	35° 31' 21"	260	1	
7	Hagal Stream	GG	32° 38' 35"	35° 32' 32"	10	17	S-3
8	Tula Quarry	GQ	32° 38' 41"	35° 32' 45"	-47	7	S-9
9	Teverya-1	TV-1	32° 47' 58"	35° 31' 52"	-145	2	S-4
10	Teverya-2/3	TV-2/3	32° 48' 12"	35° 31' 20"	-88	7	S-5
11	Newe Ur-2	NwU	32° 36' 51"	35° 32' 03"	-200	1	
12	Kokhav HaYarden	KH	32° 34' 58"	35° 31' 25"	230	11	S-7
13	Zemah-1(*)	Z-1	32° 41' 23"	35° 35' 51"	-192	4	S-8

Note: * Data of location 13 correspond to the work of Raab et al. (1997)

TABLE A2. MINERALOGICAL COMPOSITION OF THE STUDIED SAMPLES

Location	Sample	Lithology	Formation	Unit	Height (m)	Calcite	Dolomite	Phyllos.	Afs.	Pl.	Qtz	Others
Newe Ya'ar	BG-157	Clay	Bira	b2	n/d	<3	bdl	80	<5	<5	10-15	
Migdal HaEmeq	MH-580	Limestone	Gesher	g3	92.4	95 - 100	bdl	bdl	bdl	bdl	<0.5	
	MH-576A	Limestone		g3	89.8	90 - 95	bdl	10	bdl	bdl	<1	
	MH-571	Limestone		g2	83.7	95 - 100	<0.5	bdl	bdl	bdl	<0.5	
	MH-558	Limestone		g1	65.2	95 - 100	bdl	bdl	bdl	bdl	<1	
	MH-556	Limestone	Bira	b3	61.3	95	bdl	bdl	bdl	<1	<5	
	MH-553A	Limestone		b3	56.2	95 - 100	bdl	bdl	bdl	bdl	<3	
	MH-519	Limestone		b2	33.2	85 - 90	bdl	5	bdl	<3	5	
	MH-527A	Dolomitic Limestone		b2	53.0	45	25	15 - 20	5	bdl	5	
	MH-525	Limestone		b2	44.5	85	<1	5 - 10	<3	<5	5	
	MH-523	Limestone		b2	34.1	80	<5	15	<3	bdl	<5	
Nahal Hamud-5	NH5-010	Limestone	Gesher	g3	47.3	95 - 100	<1	bdl	bdl	bdl	<1	
	NH5-009	Limestone		g3	44.3	75 - 80	15	5	bdl	bdl	<0.5	gyp.<0.5
	NH5-008	Calcareous Dolostone		g2	40.1	25	50 - 55	15 - 20	<5	<3	<0.5	
Nahal Hamud-1	ANJ-014A	Calcareous Dolostone	Gesher	g3	41.5	10	65 - 70	15 - 20	bdl	bdl	bdl	gyp.<1, AM
	ANJ-012A	Dolostone		g2	37.8	5	75	10 - 15	bdl	bdl	<5	gyp.<1
	ANJ-011A	Limestone		g2	28.6	95	bdl	<5	bdl	bdl	bdl	
	ANJ-010A	Dolostone		g2	23.0	<5	95	?	bdl	bdl	<1	
	ANJ-007B	Limestone		g2	13.0	70 - 75	10	15	bdl	<3	<3	
	ANJ-005A	Dolostone		g1	6.1	<5	70 - 75	25	bdl	<5	<3	
	ANJ-004Z	Limestone		g1	5.4	80 - 85	bdl	15 - 20	bdl	bdl	bdl	
	ANJ-004C	Dolomitic Marl	Bira	b3	4.2	10 - 15	40	35 - 40	<5	<5	<5	
	ANJ-003	Calcitic Marl		b2	3.2	50 - 55	<5	40	bdl	bdl	5	
	ANJ-001	Limestone		b2	0.3	65	<3	20 - 25	bdl	5-10	5	gyp.<1
Hurvat Ze'ev	AR-163	Dolostone	Gesher	g3	126.6	<3	70 - 75	20 - 25	bdl	?	<3	
	AR-158	Limestone		g3	122.3	85 - 90	5 - 10	<5	bdl	bdl	<1	
	AR-103	Dolostone		g2	106.8	bdl	95	<3	bdl	bdl	bdl	
	AR-085	Dolostone		g2	97.2	bdl	80	15 - 20	bdl	<3	bdl	
	AR-066	Limestone		g2	91.5	100	<1	bdl	bdl	bdl	bdl	
	AR-063	Dolostone		g1	84.3	15	70 - 75	10 - 15	bdl	bdl	bdl	
	AR-062	Limestone		g1	82.4	85 - 90	bdl	10	bdl	<3	bdl	

TABLE A2. MINERALOGICAL COMPOSITION OF THE STUDIED SAMPLES

Location	Sample	Lithology	Formation	Unit	Height (m)	Calcite	Dolomite	Phyllos.	Afs.	Pl.	Qtz	Others
Hurvath Ze'ev	AR-095	Limestone	Bira	b3	79.6	85	<1	10	bdl	<5	<1	
	AR-097	Limestone		b3	76.4	80 - 85	bdl	15	bdl	bdl	<1	2.53
	AR-090W	Limestone		b2	69.0	60 - 65	<3*	30 - 35	?	?	<5	
	AR-090G	Calcitic Marl		b2	68.8	20 - 25	bdl	50	5	?	20	3.44
	AR-136W	Limestone		b2	65.1	50	5	25 - 30	bdl	15	<3	CT?, AM
	AR-039	Dolostone		b2	60.1	bdl	60 - 65	25 - 30	bdl	5	5	
	AR-132	Dolostone		b2	56.2	<1	70 - 75	25	bdl	bdl	bdl	
	AR-031	Dolostone		b2	55.1	<5	55 - 60*	30	bdl	5	<3	
	AR-030	Dolostone		b2	53.7	<1	65*	15 - 20	bdl	15	bdl	
	AR-023	Limestone		b1	44.5	85	<1	10	bdl	<3	<1	
	AR-152	Dolomitic Limestone		b1	37.7	40 - 45	25*	15	bdl	10-15	bdl	3.00
	AR-060L	Calcareous Dolostone		b1	35.9	10	50*	30	bdl	5	<3	
	AR-060B	Dolomitic Marl		b1	35.6	5 - 10	35 - 40*	40	bdl	10	5	
	AR-007	Dolostone		b1	30.1	bdl	70	25	<3	<3	<5	
	AR-122	Calcareous Dolostone		b1	21.5	25 - 30	35 - 40*	20 - 25	bdl	bdl	<3	arag. 5 - 10
Ramat Sirin	RS-II-5	Calcitic Marl	Fejjas Tuff	g7	n/d	50	bdl	50	bdl	bdl	<1	
Hagal Stream	GG-38	Limestone	Gesher	g3	68.9	90	bdl	?	bdl	<3	<3	
	GG-36	Limestone		g3	65.1	95 - 100	bdl	bdl	bdl	bdl	<0.5	
	GG-33A5	Limestone		g2	63.6	80 - 95	15 - 20	bdl	bdl	bdl	<1	
	GG32B11	Calcitic Marl		g2	53.3	15 - 20	10 - 15	45	5	<5	10-15	
	GG-32A4	Limestone		g1	40.3	70	bdl	25	bdl	<3	<3	
	GG-32A3	Dolostone		g1	35.4	bdl	70	20	<5	<3	5	
	GG-32A1	Dolomitic Marl		g1	31.7	bdl	20	50 - 55	5	5 - 10	15	?
	GG-31D3	Gypsum	Bira	b7	30.9	bdl	bdl	bdl	bdl	bdl	bdl	gyp>95
	GG-31A	Gypsum		b7	24.7	25 - 30	bdl	bdl	bdl	bdl	<3	gyp 70
	GG-30A	Limestone		b5	24.4	80 - 85	bdl	10	bdl	?	5	gyp<1
	GG-29B	Limestone		b5	24.3	75 - 80	bdl	15 - 20	bdl	<3	<5	gyp<0.5
	GG-28Z2	Limestone		b5	17.2	70 - 75	<1	20	bdl	<5	5	
	GG-28Z1	Dolostone		b5	15.2	bdl	65 - 70	25	bdl	<3	<3	
	GG-26	Limestone		b5	11.5	70	5 - 10	15 - 20	bdl	bdl	<1	
	GG-23	Dolomitic Limestone		b5	4.0	65 - 70	10	15 - 20	?	bdl	<5	gyp<1
	GG-22A	Gypsum		b5	2.3	<5	bdl	<5	bdl	bdl	bdl	gyp 90, anh,
	GG-21A	Limestone		b5	0.6	70 - 75	5	15	<5	bdl	<2	

TABLE A2. MINERALOGICAL COMPOSITION OF THE STUDIED SAMPLES

Location	Sample	Lithology	Formation	Unit	Height (m)	Calcite	Dolomite	Phyllos.	Afs.	Pl.	Qtz	Others
Tula Quarry	GQ-122	Dolomitic Limestone	Gesher	g2	23.4	65	25 – 30	<5	bdl	<3	<0.5	
	GQ-120	Dolomitic Limestone		g2	15.4	55	15 – 20	20 – 25	bdl	5	<3	
	GQ-111	Dolostone		g1	9.2	bdl	75	20	<3	bdl	<3	
	GQ-109	Calcareous Dolostone		g1	2.7	25	50 - 55	10	5	<5	<5	
	GQ-108	Limestone		g1	2.4	55	5	10	bdl	bdl	bdl	cel 30
	GQ-107	Gypsum	Bira	b7	2.3	bdl	25 – 30	bdl	bdl	bdl	1	gyp 65-70, cel
	GQ-101	Gypsum		b7	0.4	20	bdl	bdl	bdl	bdl	5	gyp 75, cel
Teverya 2/3	TV-049	Dolostone	Gesher	g3	33.2	bdl	70 – 75	20	<1	<3	bdl	
	TV-048	Clay		g3	33.0	bdl	<1	70	5	5	20	
	TV-042	Dolostone		g2	22.9	bdl	55	30 - 35	bdl	<3	5-10	
	TV-035	Dolostone		g2	14.3	bdl	85	15	bdl	<1	<0.5	
	TV-032	Dolomitic Marl		g1	12.4	bdl	50 – 55	35 – 40	bdl	5	5-10	
	TV-028	Dolomitic Limestone	Bira	b2	10.3	50 – 55	10	15	<5		20	
	TV-020	Limestone		b2	0.3	60	<1	20	<5		15	
Teverya 1	TV-010	Dolostone	Bira	b2	11.9	bdl	95	<5	bdl	<2	<0.5	
	TV-001	Dolostone		b2	0.4	bdl	65 - 70	25 – 30	bdl	5	5	
Newe Ur-2	NU-1821	Gypsum	Bira	b6	-21.0	bdl	bdl	bdl	bdl	bdl	bdl	gyp 95-100, cel
Kokhav HaYarden	KH-480	Calcareous Dolostone	Bira	b2	311.7	20 - 25	45 - 50	30	bdl	bdl	<3	
	KH-472	Dolostone		b2	282.2	bdl	65	30 – 35	<3	bdl	<3	
	KH-469	Dolostone		b2	276.8	bdl	70 – 75	25 – 30	bdl	<1	bdl	gyp <1, 4.21
	KH-465	Dolostone		b2	275.6	bdl	75 – 80	15 – 20	<3	bdl	<3	
	KH-464	Dolostone		b2	274.3	bdl	100	bdl	bdl	bdl	bdl	4.21
	KH-454	Dolostone		b1	224.6	5	80	15	bdl	bdl	<1	4.23
	KH-448	Dolostone		b1	212.9	bdl	60 – 65	30 – 35	<3	<3	<3	gyp <1
	KH-446	Dolostone		b1	211.8	bdl	65 – 70	25 – 30	<3	bdl	<3	
	KH-442	Dolostone		b1	190.0	bdl	75 – 80	15	5	bdl	<3	
	KH-441	Dolostone		b1	184.2	bdl	50	25	bdl	20	5	
	KH-440	Dolomitic Marl		b1	183.0	bdl	50	35 – 40	10	bdl	<3	

Note: Abbreviations and remarks.

Phyllos.: phyllosilicates, Afs.: alkali feldspar, Pl.: plagioclase, Qtz: quartz,

*: dolomite with calcic-dolomite, gyp: gypsum, hem: Hematite, Opal CT: Opal Cristobalite-Trydimite, aug.: augite, cel.: celestine, anh.: anhydrite,

AM: amorphous material, arag: aragonite, pyr: pyrite,

2.20, 2.53, 3.00, 3.44, 3.52, 4.21, 4.23: unidentified mineral picks.

bdl: below detection limit.

TABLE A3. CHEMICAL COMPOSITION OF THE STUDIED SAMPLES

Location	Sample	Lithology	Formation	SiO ₂ (wt.%)	Al ₂ O ₃ (wt.%)	CaO (wt.%)	MgO (wt.%)	SO ₃ (wt.%)	Ba (ppm)	Sr (ppm)	Remarks
Migdal HaEmeq	MH-576A	Limestone	Gesher	8.34	2.48	48.54	1.06	≤1	124	187	
	MH-571	Limestone		2.48	0.65	54.98	0.46	≤1	104	170	
	MH-553A	Limestone	Bira	3.41	0.44	55.08	0.27	≤1	86	150	
	MH-527A	Dolomitic Limestone		25.78	3.75	27.10	8.44	≤1	120	343	
	MH-523	Limestone		16.50	3.98	35.88	2.47	≤1	145	304	
Nahal Hamud-5	NH5-010	Limestone	Gesher	1.44	0.22	56.79	0.80	≤1	13	442	
Nahal Hamud-1	ANJ-014A	Calcareous Dolostone	Gesher	6.22	1.50	28.70	16.69	≤1	99	2309	
	ANJ-011A	Limestone		3.15	0.81	56.10	0.54	≤1	457	183	
	ANJ-010A	Dolostone		4.08	0.51	30.16	19.63	≤1	44	321	
	GR-010	Dolostone		4.24	0.55	31.48	20.43	≤1	42	329	Duplicate
	ANJ-007B	Limestone		10.71	1.45	42.74	3.91	≤1	109	334	
	ANJ-005A	Dolostone		14.10	2.24	23.68	15.84	≤1	152	485	
	ANJ-004Z	Limestone		11.49	2.45	48.34	1.39	≤1	2141	507	
	ANJ-004C	Dolomitic Marl	Bira	26.88	4.75	16.68	11.77	≤1	254	288	
Hurvāt Ze'ev	AR-163	Dolostone	Gesher	12.93	2.36	27.24	17.49	≤1	67	391	
	AR-158	Limestone		3.50	0.90	52.98	2.31	≤1	36	338	
	AR-103	Dolostone		2.80	0.71	29.51	18.27	≤1	44	625	
	GR103	Dolostone		2.71	0.75	30.97	19.81	≤1	37	613	Duplicate
	AR-085	Dolostone		10.96	2.36	25.55	14.89	≤1	82	434	
	AR-066	Limestone		1.24	0.23	56.89	0.56	≤1	10	233	
	GR066	Limestone		1.27	0.21	56.79	0.54	≤1	10	232	Duplicate
	AR-062	Limestone		2.80	0.98	56.16	0.59	≤1	97	217	
	AR-095	Limestone	Bira	12.02	2.96	51.76	1.08	≤1	104	410	
	AR-097	Limestone		8.85	2.03	48.31	1.26	≤1	53	334	
	AR-090W	Limestone		24.36	5.48	28.66	3.11	≤1	4219	491	
	AR-132	Dolostone		8.68	2.10	29.05	18.50	≤1	357	569	
	AR-031	Dolostone		6.58	1.78	26.76	16.95	≤1	53	342	
	AR-023	Limestone		9.39	1.30	48.62	2.51	≤1	56	371	
	GR023	Limestone		8.86	1.29	49.59	2.57	≤1	54	371	Duplicate
	AR-007	Dolostone		17.70	3.27	23.35	17.14	≤1	171	394	
	AR-122	Calcareous Dolostone		15.94	3.37	27.33	10.08	≤1	82	612	

TABLE A3. CHEMICAL COMPOSITION OF THE STUDIED SAMPLES

Location	Sample	Lithology	Formation	SiO ₂ (wt.%)	Al ₂ O ₃ (wt.%)	CaO (wt.%)	MgO (wt.%)	SO ₃ (wt.%)	Ba (ppm)	Sr (ppm)	Remarks
Hagal Stream	GG-36	Limestone	Gesher	2.10	0.39	55.04	0.95	1.46	74	396	
	GG-33A5	Limestone		1.27	0.15	47.87	6.03	≤1	88	521	
	GG-32A1	Dolomitic Marl		23.72	3.02	19.85	15.40	≤1	113	1230	
	GG-31D3	Gypsum	Bira	1.02	0.23	27.41	0.14	44.51	22	1453	
	GG-31A	Gypsum		3.28	0.66	34.82	0.63	35.60	30	3238	
	GG-29B	Limestone		24.24	4.33	34.28	1.60	1.52	50	472	
	GG-27B	Gypsum		2.32	0.62	33.43	0.41	44.72	270	7879	
	GG-26	Limestone		11.41	3.19	40.02	3.53	2.15	108	1163	
	GG-22A	Gypsum		5.43	1.39	17.40	0.69	42.82	440	13377	
	GG-21A	Limestone		11.85	2.89	43.35	2.75	1.49	464	2290	
Teverya 2/3	TV-049	Dolostone	Gesher	16.40	4.70	22.20	16.16	≤1	69	276	
	TV-035	Dolostone		11.20	2.60	25.92	17.93	≤1	70	238	
	TV-028	Dolomitic Limestone	Bira	21.29	5.71	32.02	3.75	≤1	109	274	
Teverya 1	TV-010	Dolostone	Bira	1.31	0.28	31.42	19.25	≤1	25	361	
	TV-001	Dolostone		26.30	6.44	16.25	13.11	≤1	242	278	
Kokhav HaYarden	KH-480	Calcareous Dolostone	Bira	8.92	2.44	34.95	8.60	≤1	56	365	
	KH-469	Dolostone		3.65	1.11	25.49	17.31	≤1	580	243	
	KH-464	Dolostone		7.98	5.02	30.35	14.10	≤1	1108	344	
	KH-454	Dolostone		5.12	1.69	30.24	18.26	≤1	98	1067	
	KH-442	Dolostone		7.84	2.49	27.61	17.94	≤1	88	1198	
	KH-440	Dolomitic Marl		16.59	4.15	19.77	15.24	≤1	175	532	

Fig. S-1 Hurvat Ze'ev Section (HZ)

Fig. S-2 Nahal Hamud Composite Section (NH-1; NH-5)

Fig. S-3 Nahal Hagal Section (GG)

Fig. S-4 Teverya Lower Section (TV-1)

Fig. S-5 Teverya Upper Section (TV2/3)

Fig. S-6 Migdal HaEmeq Section (MH)

Fig. S-7 Kokhav HaYarden Section (KH)

Fig. S-8 Zemah-1 boerhole (Z-1) ($^{87}\text{Sr}/^{86}\text{Sr}$ data of Raab et al., 1997)

Series	Group	Zemah Units	Fm.\Unit	Depth (m)	Lithology	Description	⁸⁷ Sr/ ⁸⁶ Sr soluble fraction
Pleistocene	Dead Sea	Argillaceous	EEH-Ub-Ls	0		Marls, carbonates and conglomerates.	
		Basalt	Cover Basalt	500		Basalt with conglomerates and a few marl beds.	
Marly Calcareous		Geshor	1000		Marls and carbonates with organic material and pyrite. Alternation of anhydrite, dolomite and marl.	0.70750	
Evaporitic Igneous Unit		Bira	1500		Halite units with thin beds of marl, clay and anhydrite.		
			1800		Magmatic body.	0.70917	
			2000		Thick units of halites alternated with thin beds of marls and gypsum.		
			2500		Alternations of marls and halites beds with magmatic bodies.	0.71090	
			3000		Alternations of carbonates and halites beds with magmatic bodies.		
			3500			0.70729	
			4000		Carbonates, marl and conglomerates with magmatic bodies.		
Red Beds	Hordos	4249

Fig. S-9 Tula Quarry Section (GQ)

Fig. S-10 Legend indicates the lithology and structure symbols noted in all columnar sections of • repository data figures S1 to S9

Figure S-11. Lateral W-E schematic cross section in the northern valleys.

Plate 1 caption

Photomicrographs and Scanning Electron Microscope images of the carbonate textures from the Bira and Gesher Formations. D- dolomite; Ca- calcite; Cl- clay; (A-B) Sample DS-7 of Dolomitic mudstone from the Bira Formation. Dolomite crystals are mostly subhedral, smaller than $\sim 7\ \mu\text{m}$ and closely associated with clays. (C-D) Sample DS-10 of Calcitic gastropod floatstone with an argillaceous wackstone matrix from the Bira Formation. Intraclasts size vary between sand and gravel. Pellets are common (blue arrows) and calcite microsparite crystals mostly appear as drusy texture (red arrows) in porous or dissolved areas. (E-F) Sample DS-62 of mudstone with micrite grains from the Gesher Formation. Calcite crystals show sparry and sharp texture and are closely associated with clays. (G-H) Sample DS-66 of dolomitic mudstone from the Gesher Formation. Dolomite crystals are subhedral, smaller than $\sim 7\ \mu\text{m}$ and closely associated with clays.

Plate 2 caption

Selected images of gypsum sediments from the Bira Formation (for description of Subfacies see Rozenbaum et al., 2019). (A) (Subfacies B3c). Alternations of selenite gypsum and laminated gypsum. Tula Quarry. (B) (Subfacies B3c). Selenite gypsum texture on the top of the Bira Formation on the Hagal Steam section.