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# Supplemental Material

**Text.** Description of the columnar sections

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

**Table A2.** Mineralogical composition of the studied samples.

**Table A3.** Chemical composition of the studied samples.

**Figures S1–S9.** 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). ($^{87}Sr/^{86}Sr$ 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 sharped 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 $^{87}Sr/^{86}Sr$ SAMPLES STUDIED IN THE CURRENT RESEARCH

| Serial N° | Location | Symbol | Coordinates | | Section (m.s.l.) | $^{87}Sr/^{86}Sr$ 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 | |
| | 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 | |
| Migdal | MH-571 | Limestone | | g2 | 83.7 | 95 - 100 | <0.5 | bdl | bdl | bdl | <0.5 | |
| HaEmeq | 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 | NH5-010 | Limestone | Gesher | g3 | 47.3 | 95 - 100 | <1 | bdl | bdl | bdl | <1 | |
| Hamud-5 | 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 | |
| | 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 |
| Nahal | ANJ-011A | Limestone | | g2 | 28.6 | 95 | bdl | <5 | bdl | bdl | bdl | |
| Hamud-1 | 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 |
| | AR-163 | Dolostone | Gesher | g3 | 126.6 | <3 | 70 – 75 | 20 – 25 | bdl | ? | <3 | |
| Hurvat | AR-158 | Limestone | | g3 | 122.3 | 85 - 90 | 5 - 10 | <5 | bdl | bdl | <1 | |
| Ze'ev | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Hurvat | AR-090W | Limestone | | b2 | 69.0 | 60 - 65 | <3* | 30 - 35 | ? | ? | <5 | |
| Ze'ev | 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 | |
| | GG-38 | Limestone | Gesher | g3 | 68.9 | 90 | bdl | ? | bdl | <3 | <3 | |
| Hagal | GG-36 | Limestone | | g3 | 65.1 | 95 - 100 | bdl | bdl | bdl | bdl | <0.5 | |
| Stream | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 | |
| Tula | GQ-111 | Dolostone | | g1 | 9.2 | bdl | 75 | 20 | <3 | bdl | <3 | |
| Quarry | 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 |
| | TV-049 | Dolostone | Gesher | g3 | 33.2 | bdl | 70 – 75 | 20 | <1 | <3 | bdl | |
| Teverya | TV-048 | Clay | | g3 | 33.0 | bdl | <1 | 70 | 5 | 5 | 20 | |
| 2/3 | 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 | TV-010 | Dolostone | Bira | b2 | 11.9 | bdl | 95 | <5 | bdl | <2 | <0.5 | |
| 1 | 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 |
| | KH-480 | Calcareous Dolostone | | b2 | 311.7 | 20 - 25 | 45 - 50 | 30 | bdl | bdl | <3 | |
| Kokhav | KH-472 | Dolostone | | b2 | 282.2 | bdl | 65 | 30 – 35 | <3 | bdl | <3 | |
| HaYarden | KH-469 | Dolostone | Bira | 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: bellow detection limit.

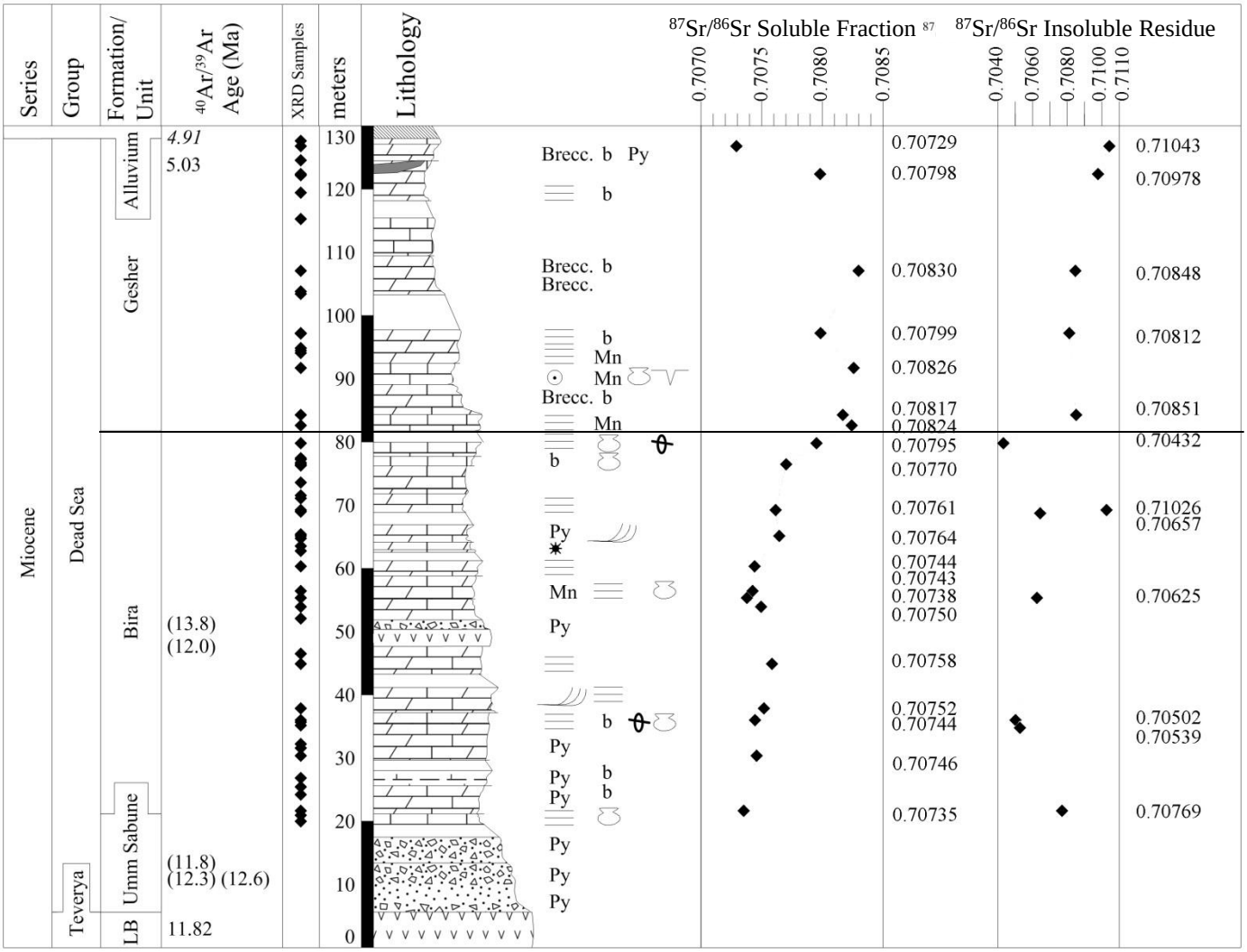
TABLE A3. CHEMICAL COMPOSITION OF THE STUDIED SAMPLES

| Location | Sample | Lithology | Formation | $SiO_2$ (wt.%) | $Al_2O_3$ (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 | | 6.22 | 1.50 | 28.70 | 16.69 | ≤1 | 99 | 2309 | |
| | ANJ-011A | Limestone | Gesher | 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 | |
| Hurvat 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 | |

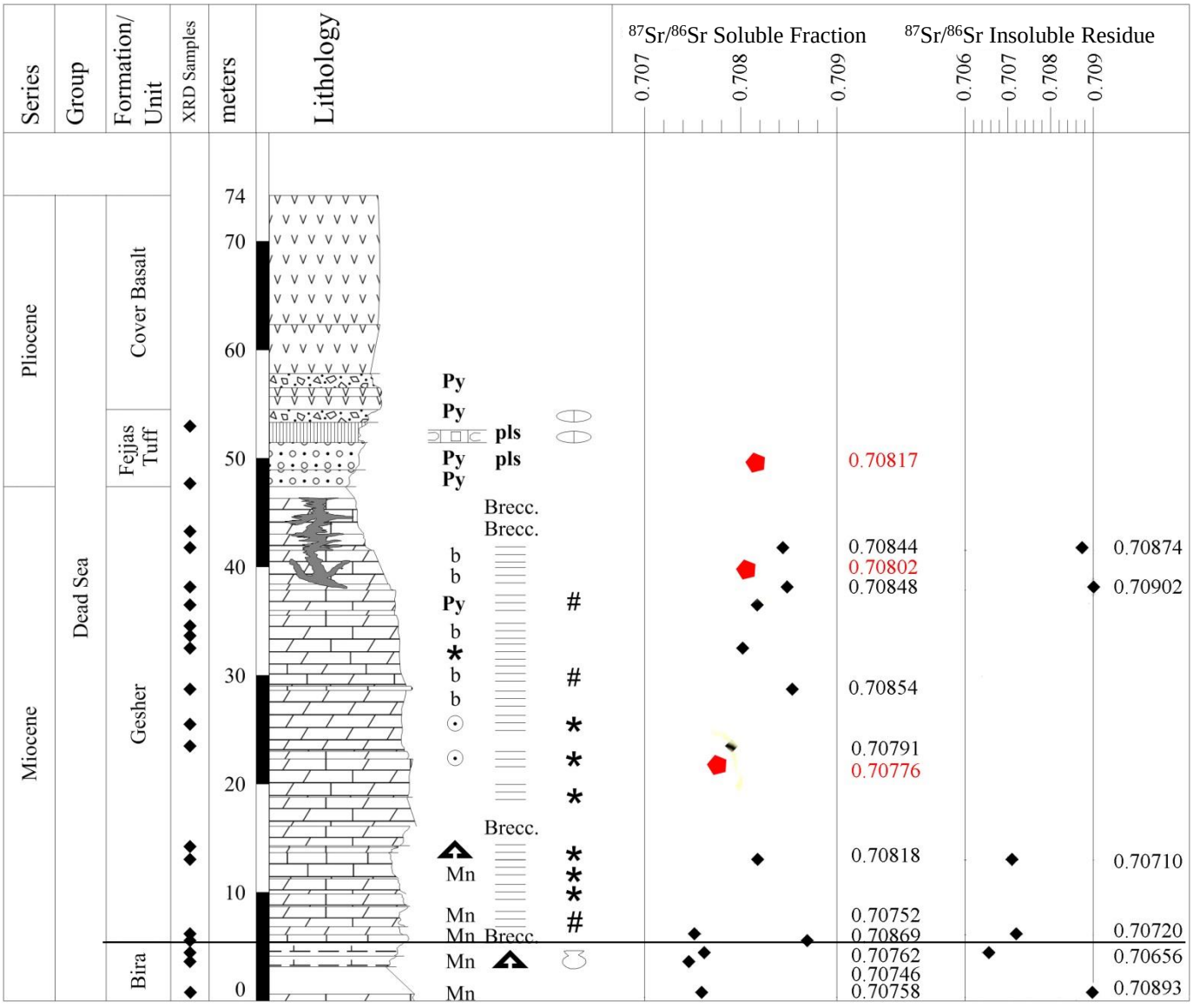
TABLE A3. CHEMICAL COMPOSITION OF THE STUDIED SAMPLES

| Location | Sample | Lithology | Formation | $SiO_2$ (wt.%) | $Al_2O_3$ (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 | | 8.92 | 2.44 | 34.95 | 8.60 | ≤1 | 56 | 365 | |
| | KH-469 | Dolostone | Bira | 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 | |

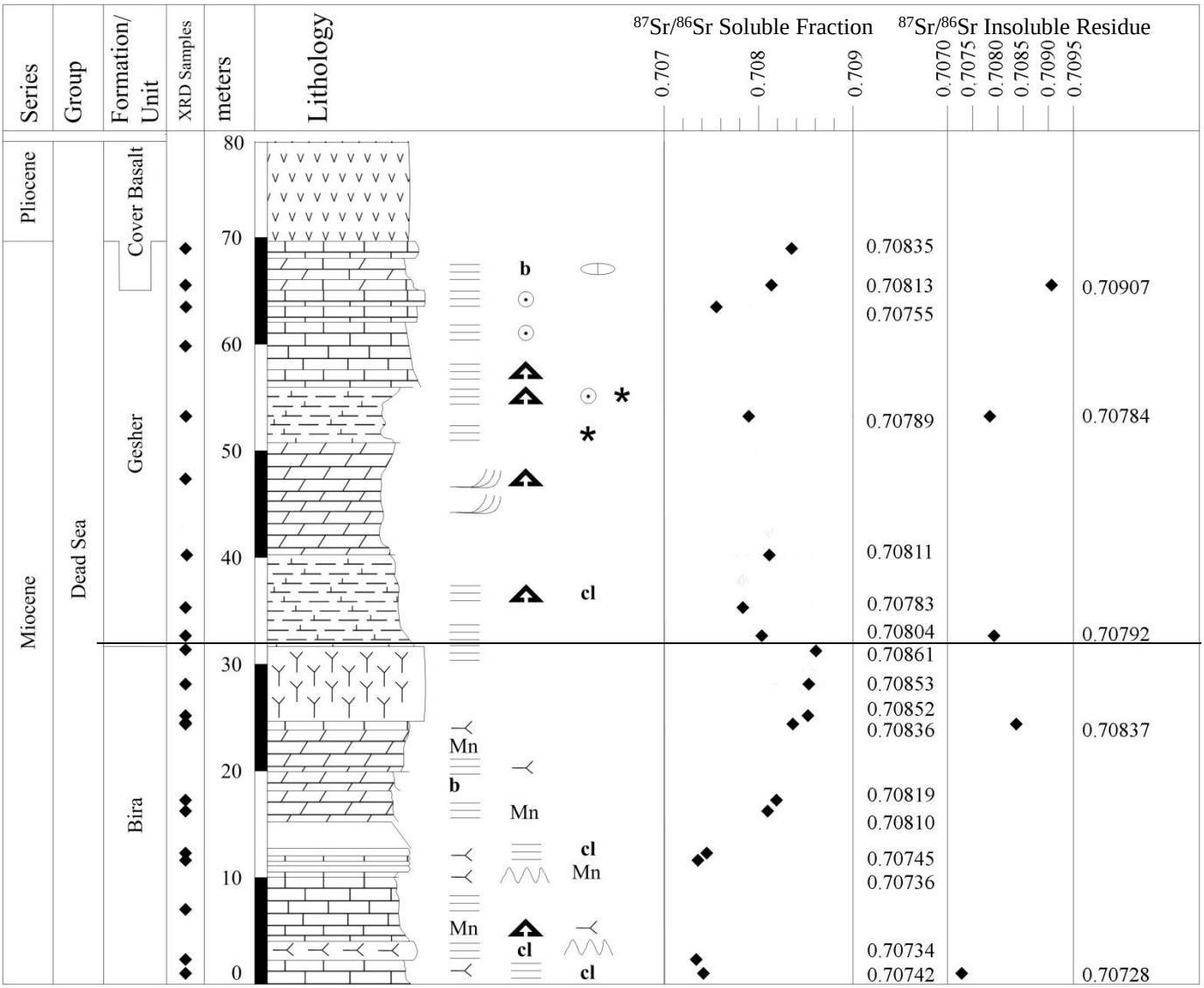
# Fig. S-1 Hurvat Ze'ev Section (HZ)



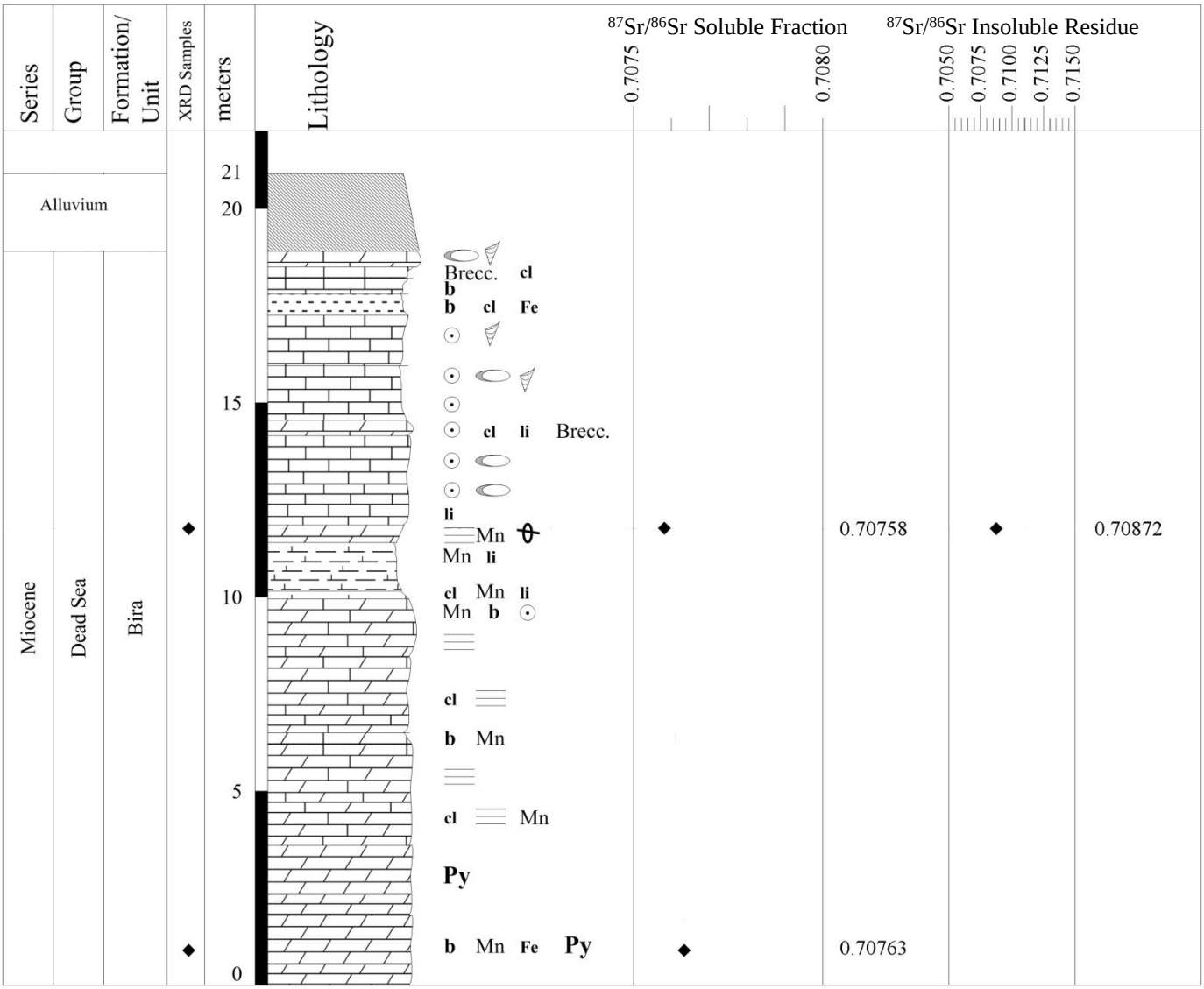
# Fig. S-2 Nahal Hamud Composite Section (NH-1; NH-5)



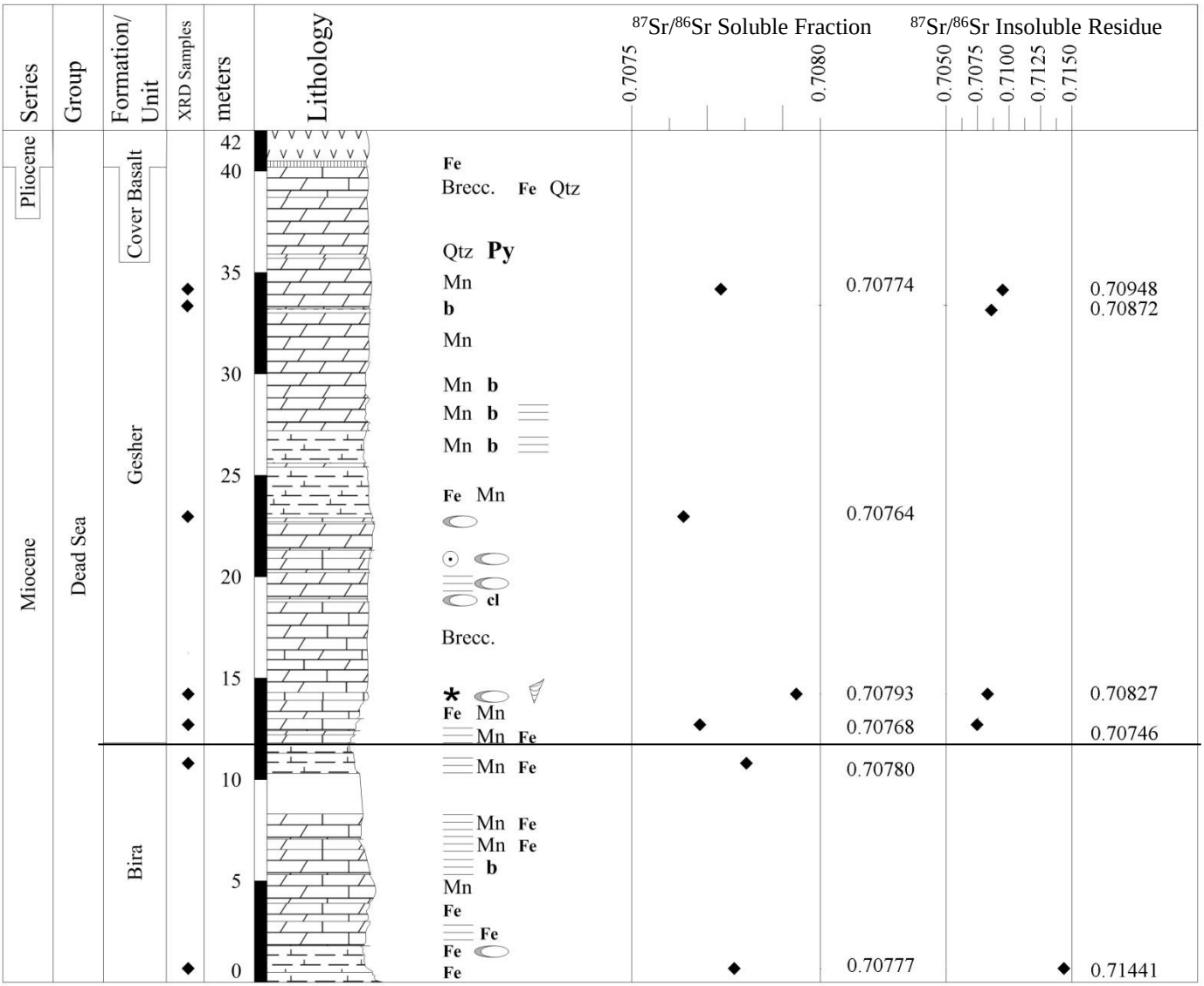
# Fig. S-3 Nahal Hagal Section (GG)



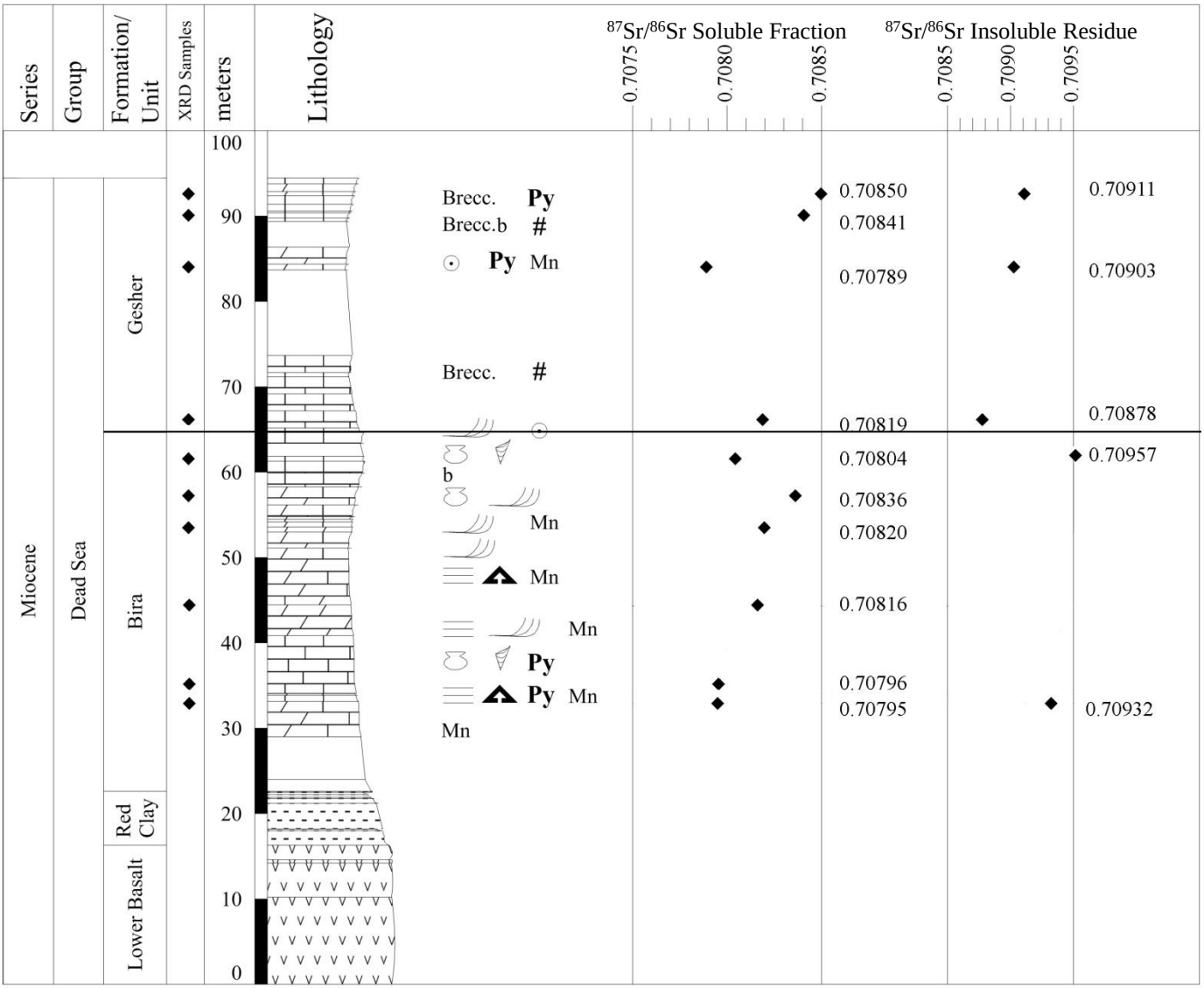
# Fig. S-4 Teverya Lower Section (TV-1)



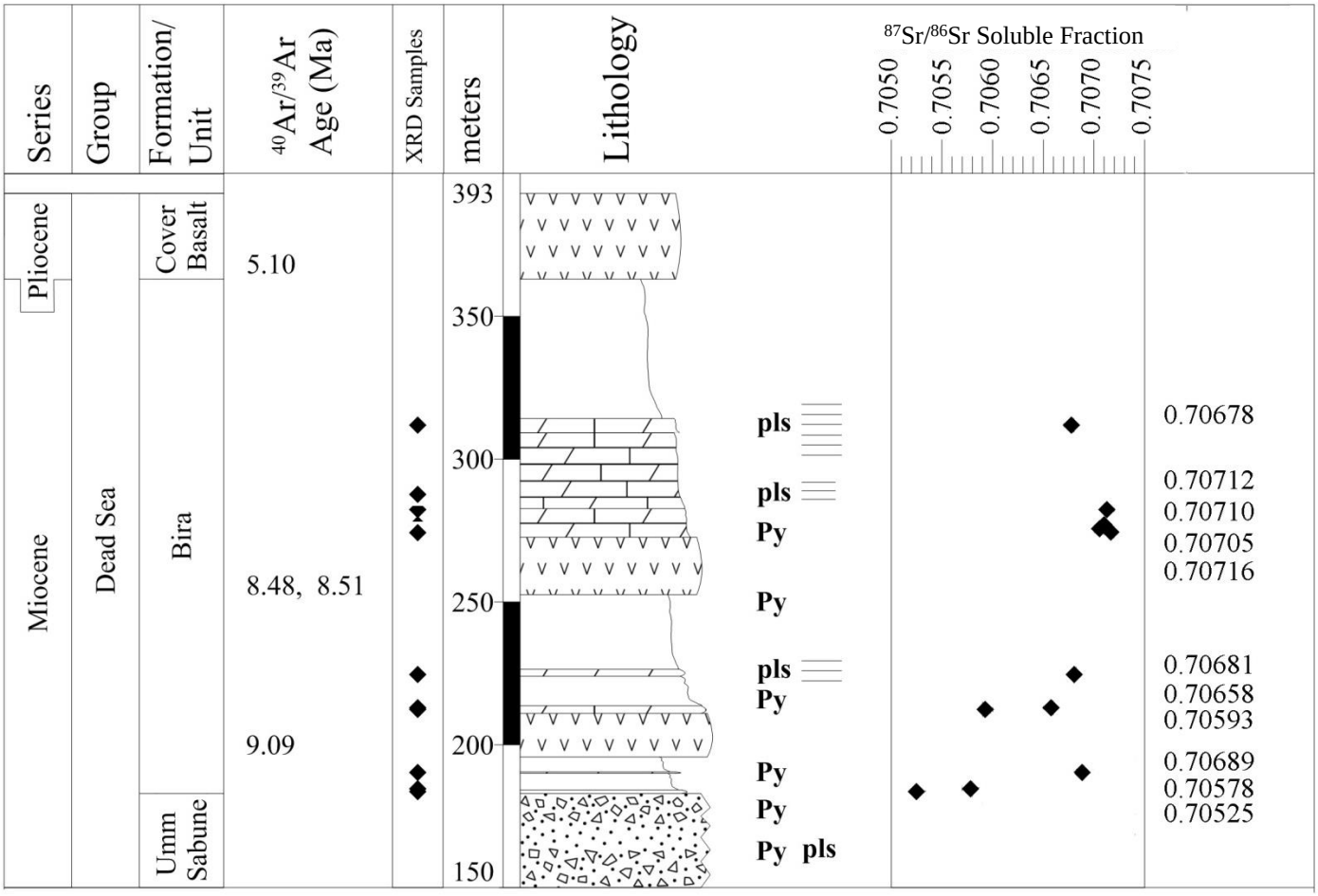
# Fig. S-5 Teverya Upper Section (TV2/3)



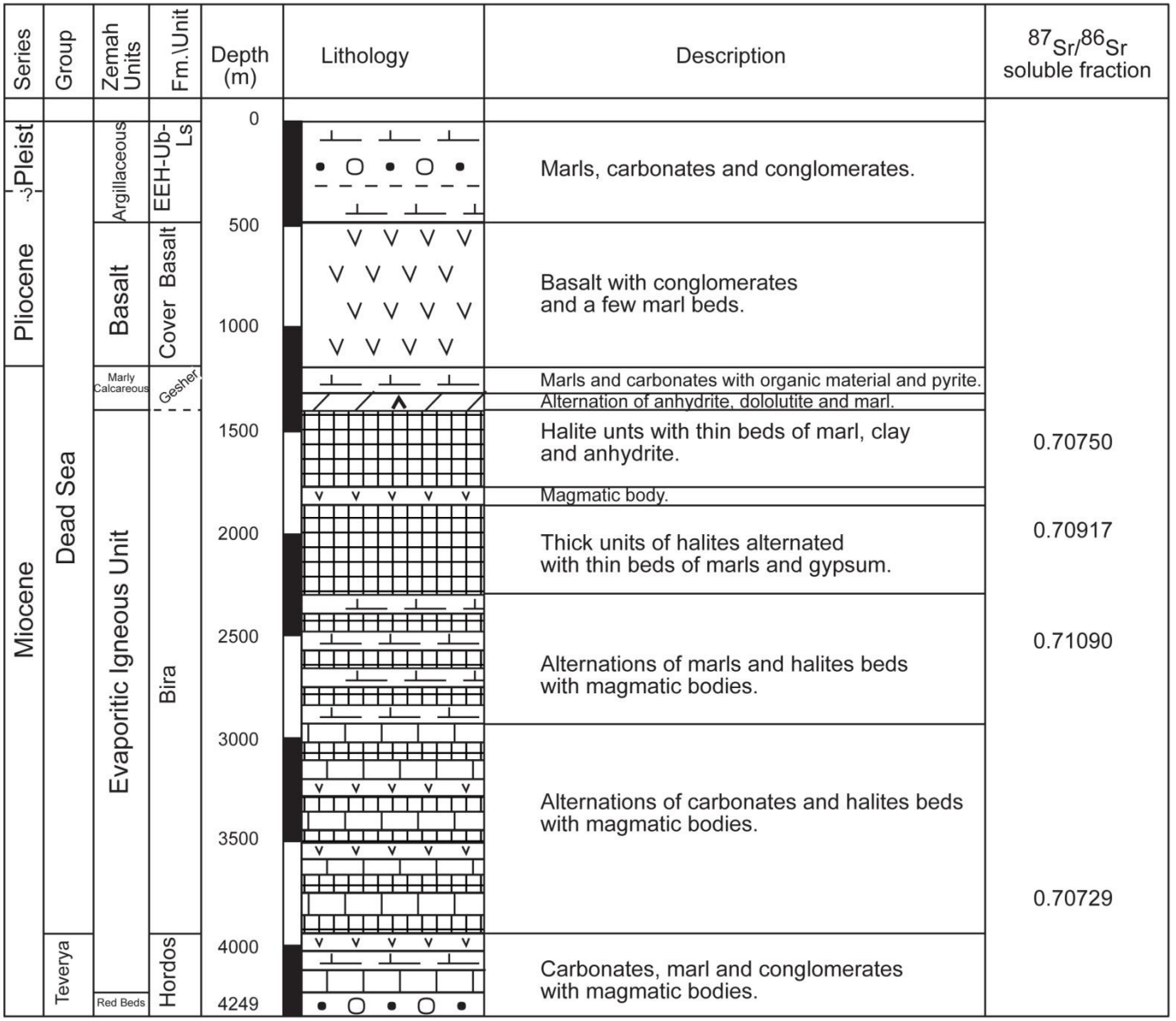
# Fig. S-6 Migdal HaEmeq Section (MH)



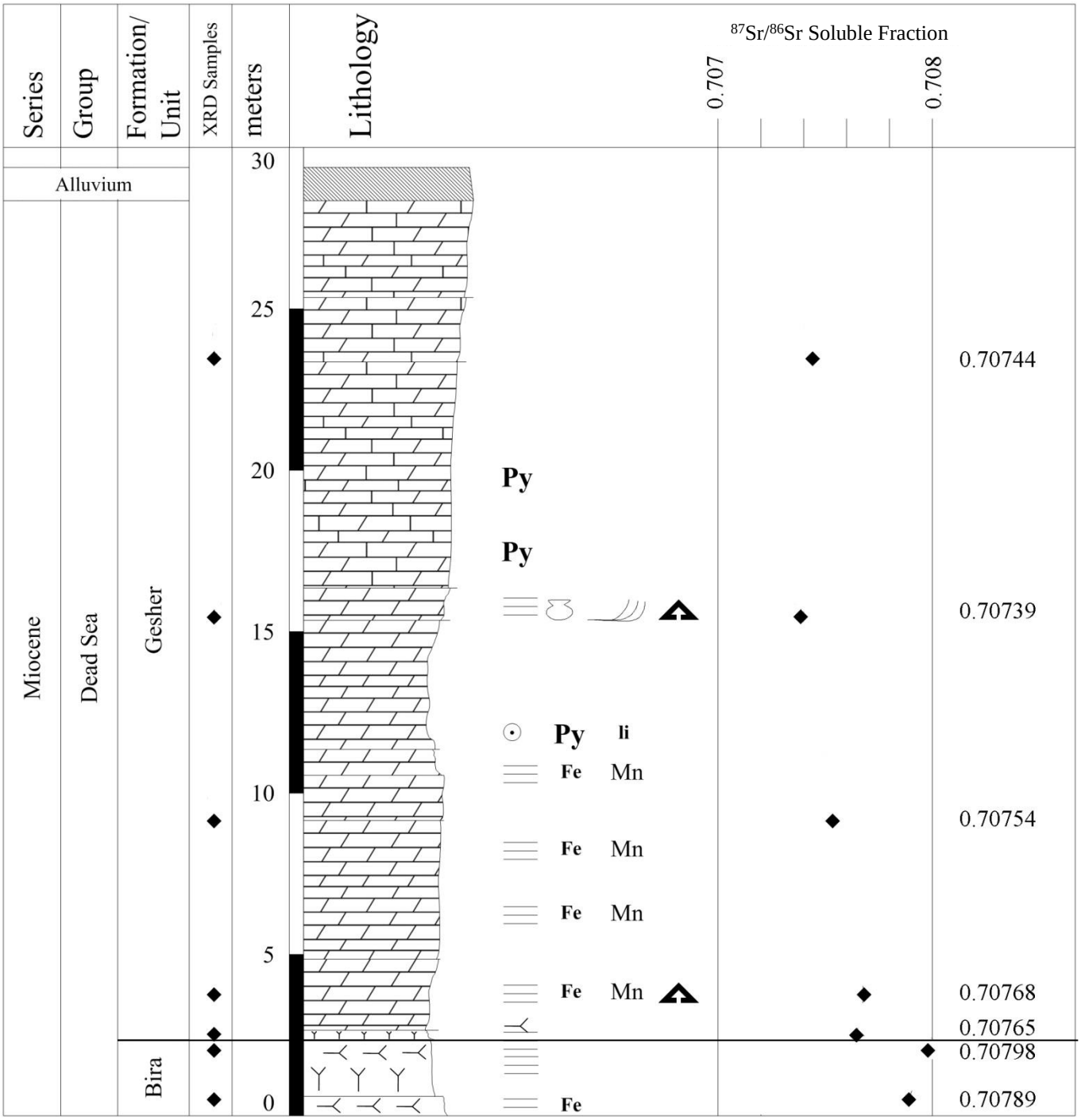
# Fig. S-7 Kokhav HaYarden Section (KH)



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



# Fig. S-9 Tula Quarry Section (GQ)



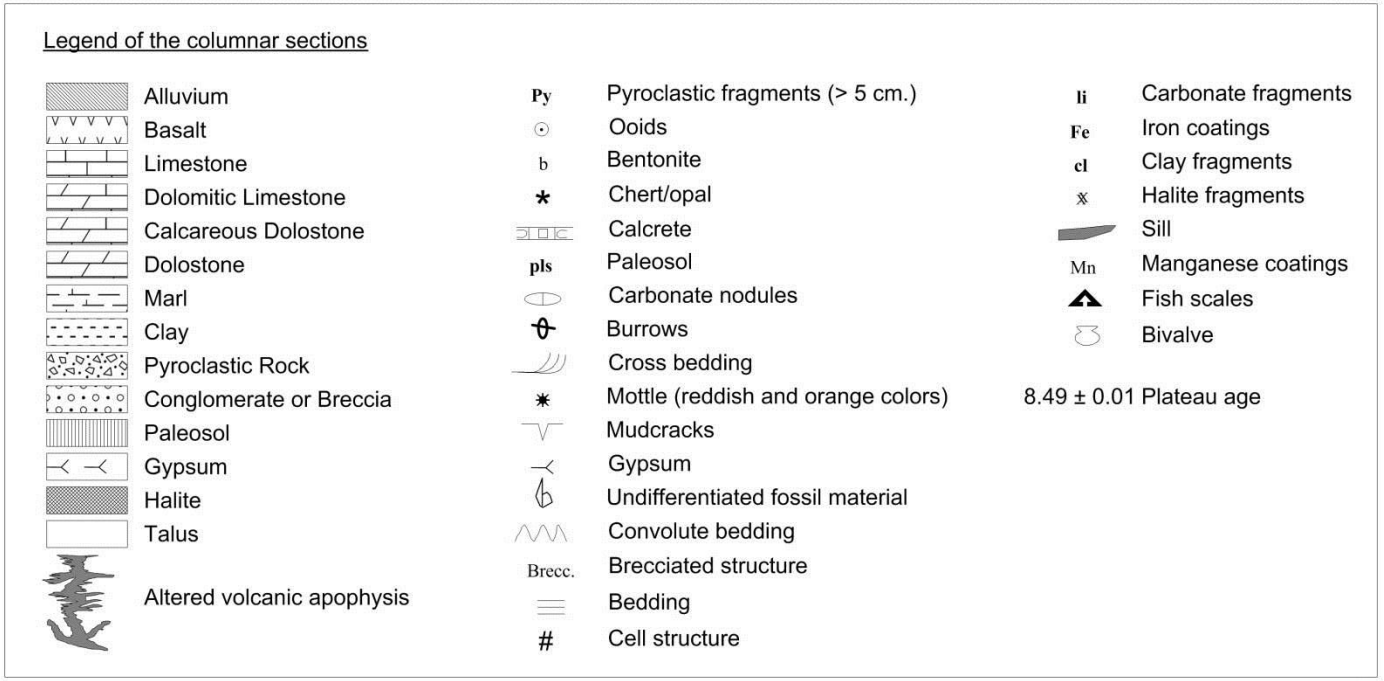
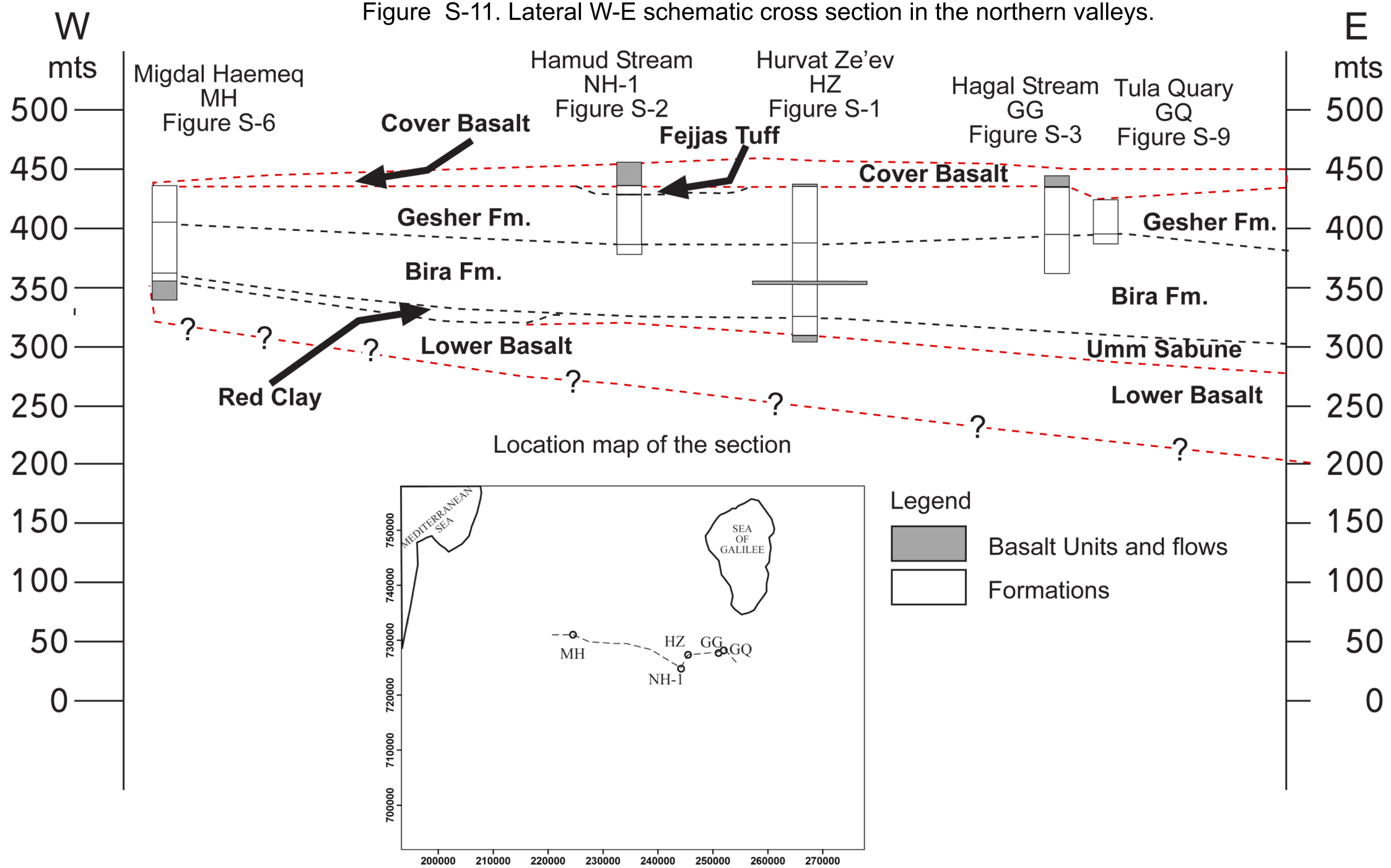


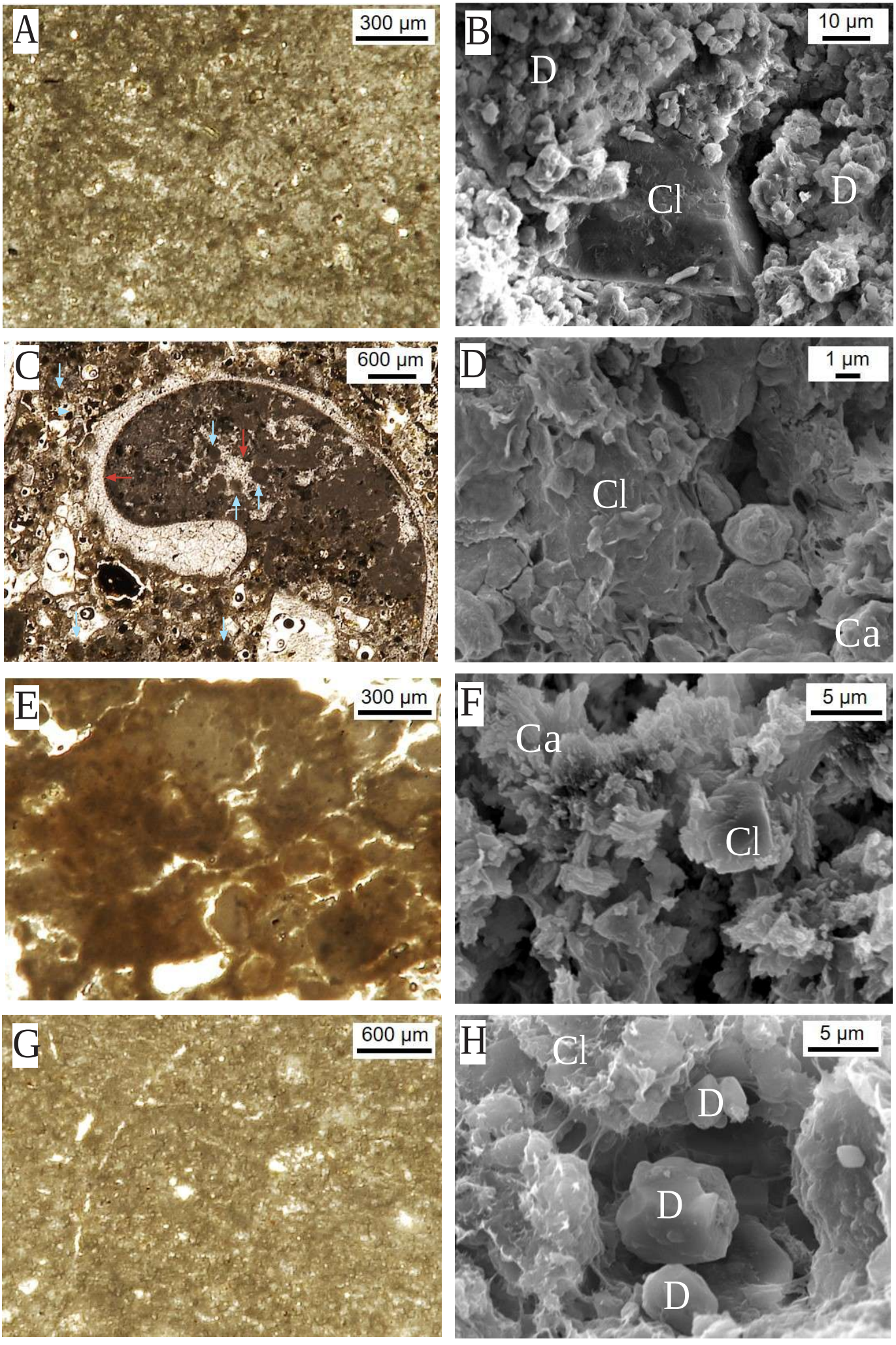

Fig. S-10Legend indicates the lithology and structure symbols noted in all columnar sections of repository data figures S1 to S9

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 ~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 sharped 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.


A
300 μm
B
10 μm
D
Cl
D
C
600 μm
D
1 μm
Cl
Ca
E
300 μm
F
5 μm
Ca
Cl
G
600 μm
H
5 μm
Cl
D
D
D

## 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.