Supplement of Solid Earth, 10, 1451–1468, 2019
https://doi.org/10.5194/se-10-1451-2019-supplement

Solid Earth Open Access EGU

Supplement of

Sinkholes and uvalas in evaporite karst: spatio-temporal development with links to base-level fall on the eastern shore of the Dead Sea

Robert A. Watson et al.

Correspondence to: Robert A. Watson (robert.watson@uni-graz.at) and Eoghan P. Holohan (eoghan.holohan@ucd.ie)

Sinkholes and uvalas in evaporite karst: spatio-temporal development with links to base-level fall on the eastern shore of the Dead Sea: Supplementary Material

1 Optical Satellite Imagery, Metadata

Year	Sensor	Date Acquired	Acquisition Time	Off-Nadir View Angle (°)	Collection Azimuth
2002	Quickbird	19-Jun	08:14	25.4	62.6
2002	Quickbird	07-Jul	08:14	25.1	106.3
2004	Quickbird	20-Oct	08:21	12	90.1
2005	Quickbird	28-Oct	08:37	3.3	120.1
2006	Quickbird	18-Nov	08:42	11	131.3
2007	Quickbird	28-Aug	08:43	13.8	161.9
2008	Worldview 1	20-Apr	08:26	18.3	240.3
2009	GeoEye-1	09-Aug	08:32	19.3	223.9
2010	GeoEye-1	29-Jul	08:27	13.2	226.3
2011	Worldview 1	26-Aug	08:38	5.2	104.7
2012	Quickbird	05-Mar	07:42	19.8	119
2013	Pleiades-1A	19-Jun	08:29	23.9	179.9
2014	Worldview 3	23-Sep	08:06	21.1	59.8
2015	Pleiades-1A	05-Jun	08:21	21.8	180.1
2016	Pleiades-1A	25-Apr	08:20	20.6	180.1
2017	Pleiades-1A	16-Apr	08:31	7.1	180.1

2 Optical Satellite Imagery, Error Analysis

GCP	2017	2016	2015	2014	2013	2012	2011
1	0.61	0.75	2.31	1.01	1.08	0.66	0.78
2	0.65	0.48	1.32	n/a	0.63	n/a	n/a
3	0.41	1.26	1.45	2.4	1.03	0.82	8.79
4	0.66	0.723	1.34	0.78	0.35	1.74	3.85
5	0.21	0.66	1.12	0.79	0.72	0.5	5.96
6	0.46	0.34	0.71	1.98	0.62	0.79	3.24
7	0.49	1.62	0.83	0.69	1.56	0.68	3.2
8	0.25	3.26	1.54	n/a	1.71	n/a	n/a
9	0.58	1.13	1.81	n/a	1.81	n/a	n/a
10	0.32	2.82	2.6	1.73	1.5	1.89	2.69
RMSE	0.49	1.61	1.61	1.48	1.21	1.14	4.72

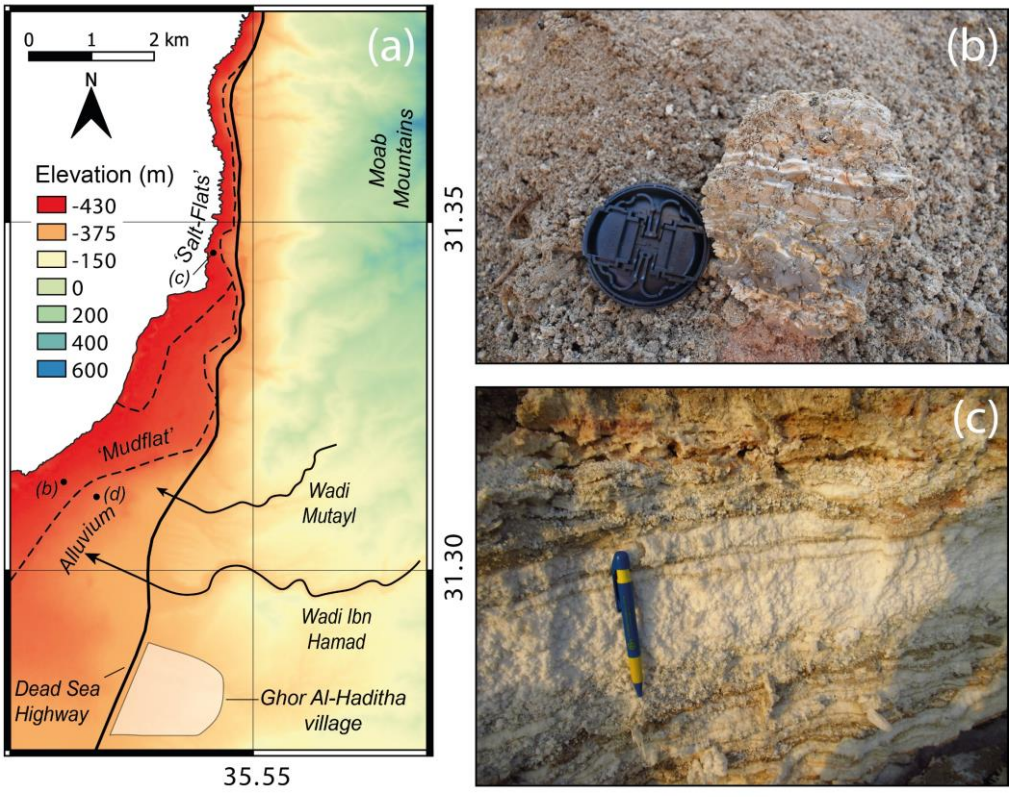
GCP	2010	2009	2008	2007	2006	2005	2004	2002
1	1.32	1.57	1.9	2.81	3.44	3.02	2.41	2.93
2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3	21.58	28.53	24.25	8.09	n/a	n/a	n/a	n/a
4	6.95	5.73	5.33	4.57	n/a	n/a	n/a	n/a
5	9.66	10.87	8.58	3.22	n/a	n/a	n/a	2.74
6	7.71	8.28	6.33	4.24	1.44	0.77	n/a	12.45
7	8.9	8.89	8.78	5	0.61	0.73	n/a	0.76
8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10	3.73	2.92	0.87	1.43	2.29	1.1	2.62	4.95
RMSE	10.43	12.67	10.77	4.62	2.21	1.69	2.52	6.26

3 Bathymetric Data

Year	Dead Sea Level (m msl)
1967	-396.3
1981	-400.2
1992	-408.1
2000	-413.2
2002	-415.3
2004	-416.7
2005	-417.5
2006	-418.5
2007	-419.7
2008	-420.9
2009	-422.1
2010	-423.1
2011	-424.1
2012	-425.3
2013	-426.8
2014	-427.9
2015	-428.8
2016	-429.9
2017	-431.1

4 Field impressions and sedimentological descriptions of the Lisan Formation

Figure S1 (page 4): field impressions of the superficial material deposits hosting sinkholes at Ghor Al-Haditha. Photos taken during October 2018 field campaign. (a) Location map with the extents of each material as mapped at the surface (cf. Figure 1c) and the locations of the field photographs in (b), (c) and (d). (b) Hand specimen of superficial mudflat deposits collected from the bank of a stream channel. Lens cap (~7 cm diameter) for scale. The sample primarily comprises light brown mud deposits, with some laminated horizons of evaporite (~0.5 cm thick). The lower half of the sample comprises mud of a much darker colour arising from organic material within it. The mud deposits are primarily composed of weathered carbonates and clay minerals. Idiomorphic halite crystals of up to 1 cm diameter also occur throughout the sample. Some soft sedimentary deformation is visible lower in the sample. (c) Example of superficial salt-flat deposits viewed in the wall of a sinkhole. Pen (~15 cm long) for scale. The upper layers are weathered evaporite (predominantly halite and gypsum) deposits with clay mineral contamination. The middle of the photograph shows a near-continuous bed of halite with two laminated mud beds at its top (near the top of the pen). The base of this halite bed shows more pervasive mud laminations with halite crystal overgrowth. (d) example of sinkhole in alluvium with visible sedimentary succession in depth profile. People for scale. The deposits comprise poorly sorted gravels and cobbles of sizes from 1–10cm diameter, generally sub-rounded to rounded, within a matrix of finer sand (0.1–1 cm grain size). The ratio of clasts:sand is around 65:35 %. The cobbles and gravels derive their lithology from the marl deposits of the Lisan formation which are found a few kms further inland and comprise mainly carbonate minerals with some clay minerals and quartz. The sand is of a similar mineral content, though contains slightly less carbonate and more quartz. The people are standing on a patch of muddier material, of which lenses infrequently occur within the successions.


(a)
0 1 2 km
N
Elevation (m)
-430
-375
-150
0
200
400
600
Salt Flats
(c)
Moab Mountains
'Mudflat'
(b)
(d)
Alluvium
Wadi Mutayl
Wadi Ibn Hamad
Dead Sea Highway
Ghor Al-Haditha village
31.35
31.30
35.55
(b)
(c)


(d)