Supplementary information

1.Extended Methods SI

1.1 Bathymetric analysis

We compiled a bathymetric digital elevation model (DEM) for the continental slope offshore Israel using Global Mapper and ArcGIS mapping software. The compiled dataset (figure 1A, table 1SI) integrates bathymetric data acquired by multibeam sonar and gridded at 50 m interval (Hall et al., 2015), with five smaller 12.5 m bathymetric grids that were extracted as seafloor picks from commercial 3D seismic datasets (after Gvirtzman et al., 2015). As a result, the grid sizes and orientations vary according to the datasets availability and are not uniform (figure 1, table 1SI). Some of the seafloor picks (table 1SI) were obtained in the time domain and were scaled to depth using a sound water velocity of 1520 m/s (e.g. Hall et al., 2015).

Analysis of the composite bathymetric DEM was carried out in two stages. In the first stage the main recognizable slide's headscarps, lateral margins, and toe domains were manually identified and mapped. This manual interpretive mapping provided preliminary information about the magnitude, direction, and distribution of slide tracks along the investigated slope. These interpretations were used to construct the spectral analysis scheme and provide the context and controls for the spectral decomposition results. The efficacy of combined morphometric and interpretive mapping was formerly demonstrated in the delineation of events in the Storegga slide (Norway) (e.g., Micallef, Berndt, Masson, & Stow, 2007, their figure 11). Two-dimensional (2D) decomposition of spatial data has been shown to provide a broad description of both the scales and the patterns of features represented (Cazenave, Dix, Lambkin, & McNeill, 2013; Renshaw & Ford, 1984). The second analysis stage utilized therefore 2D spectral decomposition of the bathymetry to investigate the slide tracks and associated features along the slope quantitatively. Previous examples of the use of spectral decomposition in morphometric analysis include studies of de-glaciated debris slopes (Thornes, 1972), aeolian sand dunes (Cazenave et al., 2013), wave rippled seafloors (Cazenave et al., 2013; Lefebvre & Lyons, 2011; Lyons, Fox, Hasiotis, & Pouliquen, 2002) and rhythmic river bedforms (Lisimenka & Rudowski, 2013; van Dijk, Lindenbergh, & Egberts, 2008).

In the present study, the bathymetry dataset was divided into ~20 km by ~20 km rectangles, and each rectangle was re-gridded according to the resolution of the available data (figure 1, table 1SI). Rectangles that included both 50 m and 12.5 m resolution datasets were re-gridded to 25 m resolution. Each rectangle was de-trended before applying the FFT to remove the DC component (e.g., Cazenave et al., 2013), which otherwise introduces a large bias spike at zero wave number in the spectral domain. The larger regional components (the general dip of the slope) was next removed to further accentuate the desired features, such as slope scars and surface roughness (e.g., Lefebvre & Lyons, 2011) (figure 2). Removal of the regional bathymetry was achieved by the subtraction of a smoothed version of the DEM from the actual bathymetry. The smoothed DEM was created using the “smoothn.m” Matlab code by Garcia (2010, 2011), which utilizes the Discrete Cosine Transform iteratively for robust smoothing of 2D datasets. The smoothed rectangle dataset included features with a wavelength equal or larger than 12 km, which is about half the average continental slope width. The gradient of the smoothed DEM was also used to study the general regional gradient changes along the continental slope (figure 2A). Next Matlab's Gaussian tapering function was used to taper the edges of each rectangle to reduce spectral leakage associated with the finite size of the dataset (e.g. Lefebvre & Lyons, 2011; Lefebvre, Lyons, Thompson, & Amos, 2009; Lisimenka & Rudowski, 2013; Lyons et al., 2002) and further decrease the DC component (figure 2B).

The tapered residual rectangle dataset was transformed to the 2D spectral domain and visualized in 2D plots of the spectral power versus directional wave numbers (kx, ky) (figure 2). The spectral domain data were divided into three spectral slices; each slice representing the inverse of a different scale range of geomorphologic features: 100 to 50 m (~10^2 m), 1500 to 400 m (~10^3 m) and 10 km to 1500 m (~10^4 m) (figure 2), selected based on the results of the first stage's manual analysis results. Spectral slicing was done using high and low pass *n*th-order Butterworth filters (Oppenheim, Willsky, & Nawab, 1997), with the orders of the filters chosen as a tradeoff between optimal sharp truncation and the appearance of Gibbs ringing artifacts (Hu & Tonder, 1992; van Dijk et al., 2008). Each spectral slice (component) was translated back to the spatial domain and was separately draped on the original DEM (figure 2). The ~10^2 m spectral component (slice) was bound by the Nyquist wavelength of the DEM. The final mid-range slice (1500 to 400 m wavelength) was defined through an iterative examination of the spectral decomposition results. An additional spectral slice was obtained from the 10^3 m spectral component through an anisotropic filter in the slope strike direction, in order to extract slope parallel periodic perturbations that reflect fault scarps and other morphological steps. A complementary slope perpendicular 10^3 spectral component was obtained by subtracting the slope perpendicular DEM from the full 10^3 spectral component. The decomposition procedure created color-coded spectral separations of the main structural components of the continental slope bathymetry, which are interpreted next jointly with the original DEM.

1.2 Interpretation of 2D high-resolution seismic profiles

Three sources of seismic data were used: 1) TGS - 2D time migrated sections of multichannel seismic reflection profiles acquired and processed by TGS-NOPEC in 2001. 2) METEOR - 2D high resolution (~4 kHz) sections of seismic reflection profiles acquired with a “PARASOUND” parametric sub-bottom profiler onboard R/V Meteor during cruise M52/2 carried out in 2002 (Hübscher et al., 2003). 3) Yam Hadera – 3D depth migrated seismic cube acquired by PGS in 2011. Note that datasets 1 and 2 were analyzed in the two-way-time (TWT) domain, while dataset 3 was analyzed in the depth domain. Scaling of the TWT data to depth was approximated using constant seismic velocities of 1520 m/s for the water (Hall et al., 2015), 1600 for the shallow(~100 m below the seafloor) and 2000 m/s for the deeper (~1000 m below the seafloor) subsurface (based on Sagy, Gvirtzman, Reshef, & Makovsky, 2015) . The different seismic datasets and bathymetric attributes were integrated and co-interpreted using Paradigm Epos software multi-surveys Project framework.

Our criteria for identifying mass transport complexes (MTC's) related features within seismic profiles follow the criteria established in previous studies (Bull, Cartwright, & Huuse, 2008; Embley, 1976, 1980; Evans, King, Kenyon, Brett, & Wallis, 1996; Frey Martinez, Cartwright, & Hall, 2005; Hampton, Lee, & Locat, 1996; Lee et al., 2002; Normark & Gutmacher, 1988; Omeru & Cartwright, 2015). By these criteria, we interpreted lens-shaped chaotic, discontinuous or highly disrupted seismic facies as mass transport deposits. Basal shear surfaces (BSS) were recognized as continuous unconformities below the deposit lobes, sub-parallel to the underlying sedimentary layers, which may ramp up and down several layers. The headwall domains were recognized as listric concave upward continuations of the BSS, cutting upslope younger sedimentary layers.

1.3 Feature digitization and statistical analysis:

The 10^3 m bathymetric spectral component anomalies (see below) were digitized using the "Raster to polygon" ArcGIS tool, to create a shapefiles database of the mapped scars along the slope. The shapefiles were merged to create a table of the morphological properties of each slide scar (Table 2I). To estimate the excavated volume of the slide we removed from the original bathymetric DEM all the areas that overlay the scar polygon using ArcGIS "Extract by Mask" tool and created a bathymetric DEM with data holes corresponding to all the slide scar locations. This DEM was then re-interpolated to create a new DEM, in which all the slide scars are filled and smoothed approximating the morphology of the slope before the formation of the slide scars. Slide volumes were then calculated with ArcGIS "Cut Fill" tool by subtracting the actual DEM from the filled and smoothed DEM. Note that these volume calculations provide minimum estimates, as no account is taken of post-failure sediment deposition within the scars.

The ~10^2 m component was also digitized, using the "Raster to Polyline" ArcGIS tool. We converted positive amplitude anomalies, which represent debris bodies and ridges, into line shape objects. Lines longer than 1 km, suspected to be data artifacts (straight lines at the edges of the dataset, etc.), were discarded. This resulted in a shapefile, which we interpret to contain surface roughness components related to slide debris. Roughness density was calculated using ArcGIS "Line density", which calculates and compares the density of line features for each 50 m area in a 300 m search radius. These shapes were also draped on the original DEM shaded relief for a combined interpretation.

1.4 Defining the long-term slope profile:

To examine our hypothesis, that the regional (>~10^4 m) bathymetric spectral component approximates the long-term steady-state bathymetric profile, we seek to compare it with an independent estimation. Such an independent estimation of the long-term profiles is obtained here by averaging the shapes of Hübscher et al., (2016) interpreted mid-Pleistocene to present stratigraphic sequences boundaries, as imaged on seismic profiles crossing the same continental slope offshore Israel. We argue that each of the sequence boundaries represents a paleo-bathymetric profile, and thus averaging their shapes estimates the long-term bathymetric profile.

Three of the seismic sections of Hübscher et al. (2016) cross the continental slope in the true dip direction, within our study area, and outside of the deformed Palmahim and Dor Disturbance slope segments (their figure 2; b, c and d; figure SI13). For each of these sections the interpreted sequence boundaries (the top of the red, blue and gray units in the left panels of figure SI13) were vertically and horizontally shifted to overlay the current seafloor (the top of the green unit in the left panels of figure SI13), with maximum overlap in the middle-slope. This shifting yielded the left panels in figure SI13. The average of the four overlaying curve is computed by fitting an average fourth order polynomial fit, yielding the long-term estimate for each of the sections (black in the right panels), displayed (green curves) in figure 14. An average gradient was then calculated of the three long-term averaged profiles and used as a base line (gray) in figure 14.

2. Table SI1: The bathymetric datasets used in this study, for locations see figure 1.

All the data listed below, as well as the TGS 2001 survey seismic profiles (mentioned in the manuscript Methods section), are archived in the State of Israel Ministry of Energy national data archives.

#	Survey name	Survey type and units	Acquisition	Grid cell size
1	A New Bathymetric Map for the Israeli EEZ	Multibeam Depth [m]	(Hall et al., 2015)	50x50 m
2	Sara- Myra	Seismic reflection: Depth [m]	CGGVeritas 2011	12.5x12.5 m

3	Yam Hadera	Seismic reflection: Depth [m]	ION-GXT Imaging Solutions 2011	12.5x12.5 m
4	Aviya	Seismic reflection: Depth [m]	PGS 2010	12.5x12.5 m
5	Southern Israel	Seismic reflection: TWT [sec]	WesternGeco 2000	12.5x12.5 m
6	Ashqelon	Seismic reflection: Depth [m]	Delek Ltd/Avner Oil Exploration	12.5x12.5 m
7	Oz	Seismic reflection: Depth [m]	ION-GXT Imaging Solutions 2013	13.5x15 m

Table SI2: **A summary of the 105 mapped slope scars including: scar area, scar volume, headscarp water depth and headscarp location. The volumes were calculated using ArcGIS cut and fill tool, estimating the removed volume from each scar. Coordinates are in UTM zone 36N.**

Regional Segment	Area [km^2]	Volume [km^3]	Headscarp depth [m]	Y coordinate UTM [m]
Segment 1	20.295156	0.524648	-385.773712	3514267.543
Segment 1	29.655313	0.646637	-411.668274	3517871.479
Segment 1	3.703437	0.010816	-554.075684	3520700.745
Segment 1	31.35875	0.462869	-405.77298	3523520.889
Segment 1	13.005312	0.283072	-643.934998	3524426.444
Segment 1	18.749531	0.382316	-383.966431	3526382.058
Segment 1	27.875625	0.571311	-380.685059	3531391.192
Segment 1	5.626719	0.132054	-522.719849	3531790.982
Segment 1	2.597344	0.046022	-580.171631	3532149.995
Segment 1	13.485156	0.338685	-458.107574	3532407.792

Segment 1	6.400781	0.088903	-582.531677	3533742.978
Segment 2	17.082812	0.168751	-386.222931	3536303.273
Segment 2	7.847031	0.054849	-558.865295	3545155.882
Segment 2	12.793906	0.067961	-510.940948	3547709.839
Segment 2	10.669	0.133464	-178.38	3547981.55
Segment 2	4.821719	0.015047	-538.227722	3549257.582
Segment 2	7.78	0.0919	-295.64	3550382.871
Segment 2	8.4225	0.02388	-498.214417	3550658.013
Segment 2	13.659	0.139842	-173.1	3552689.083
Segment 2	9.436406	0.019966	-533.238892	3553009.54
Segment 2	10.455781	0.03523	-610.836243	3556343.436
Segment 2	7.934531	0.050902	-626.124573	3557517.625
Segment 3	10.883437	0.146569	-397.264404	3561756.91
Segment 3	18.608281	0.374071	-662.279053	3565634.251
Segment 3	19.513906	0.20223	-367.228699	3566702.436
Segment 3	4.691406	0.086713	-403.809235	3567004.57
Segment 3	9.035312	0.12601	-367.675476	3568998.063
Segment 3	5.538906	0.101017	-369.982239	3570253.218
Segment 3	3.770625	0.075499	-390.270203	3571240.908
Segment 3	12.957344	0.098647	-612.100708	3572094.147
Segment 3	22.443438	0.278832	-368.33078	3572383.85
Segment 3	9.486094	0.180185	-368.33078	3572779.565
Segment 3	4.131094	0.067767	-388.843811	3574616.832
Segment 3	13.620781	0.152461	-408.417023	3577196.111
Segment 3	5.974063	0.054114	-412.232697	3579155.312
Segment 3	5.903906	0.066328	-245.532852	3579211.484
Segment 3	2.5925	0.023455	-464.07196	3580654.546
Segment 3	9.291406	0.08712	-693.2099	3580985.86
Segment 3	8.502656	0.091602	-398.399933	3581711.036
Segment 3	1.630937	0.021997	-757.252991	3581881.502
Segment 3	9.565469	0.123756	-731.993713	3582869.556
Segment 4	5.475781	0.053093	-476.939697	3583202.053
Segment 4	2.950469	0.023627	-242.752396	3583352.773
Segment 4	2.619219	0.016881	-203.630005	3583954.582
Segment 4	6.08375	0.04089	-362.276794	3584091.946
Segment 4	3.687812	0.020918	-377.696869	3584634.109
Segment 4	7.507969	0.075461	-802.257263	3584835.037
Segment 4	2.835625	0.033948	-787.562195	3585010.558
Segment 4	1.35625	0.011023	-694.69342	3585790.877
Segment 4	1.409375	0.005076	-529.508606	3585861.171
Segment 4	0.649375	0.00273	-578.979858	3586246.614
Segment 4	6.842969	0.04745	-786.324829	3586545.008
Segment 4	2.372813	0.022104	-503.957703	3586925.478
Segment 4	1.276406	0.004316	-658.175598	3587387.475
Segment 4	4.655781	0.066166	-772.714661	3587882.502
Segment 4	8.267031	0.102173	-352.180328	3588106.632

Segment 4	3.510313	0.043605	-392.758606	3588265.53
Segment 4	3.894531	0.047962	-678.966309	3588709.163
Segment 4	1.069219	0.009589	-770.377441	3589486.929
Segment 4	1.069219	0.009589	-770.377441	3589486.929
Segment 4	0.470625	0.001254	-954.236572	3590219.501
Segment 4	3.370313	0.046747	-404.269653	3590423.367
Segment 4	1.344219	0.01241	-599.066284	3590639.082
Segment 4	0.775781	0.003001	-901.89325	3590651.362
Segment 4	9.221875	0.111279	-421.446655	3590868.982
Segment 4	5.013438	0.075083	-349.979218	3591041.604
Segment 4	2.348281	0.013663	-864.437622	3591042.296
Segment 4	0.997031	0.008512	-592.376343	3592725.579
Segment 4	4.670938	0.057271	-755.858093	3593237.266
Segment 4	0.574063	0.002409	-658.118408	3593911.24
Segment 4	6.134219	0.056235	-359.535034	3594733.977
Segment 4	4.73	0.057686	-175.428406	3594745.133
Segment 4	0.957344	0.015038	-361.164276	3596076.566
Segment 4	7.810625	0.11678	-354.618439	3596680.373
Segment 4	1.662969	0.02406	-485.785187	3598720.759
Segment 4	0.881094	0.008154	-615.835876	3599454.919
Segment 4	1.190156	0.008718	-592.163879	3599999.251
Segment 4	1.948281	0.019018	-574.699158	3600799.661
Segment 4	2.412969	0.034555	-548.62793	3601589.612
Segment 4	6.605469	0.072557	-161.065048	3601780.185
Segment 4	6.511875	0.099754	-292.926056	3602135.88
Segment 4	0.986562	0.007578	-616.674011	3602592.398
Segment 4	0.900938	0.001649	-657.010193	3603503.727
Segment 4	2.395	0.021591	-169.014999	3605793.717
Segment 4	4.134688	0.032733	-302.387238	3606685.625
Segment 4	3.727656	0.018589	-484.661469	3606807.48
Segment 4	2.492656	0.036413	-167.246994	3607340.327
Segment 4	1.698125	0.020415	-352.416901	3608277.231
Segment 4	0.497187	0.001056	-590.688538	3608964.547
Segment 4	1.109531	0.010277	-169.702072	3609051.629
Segment 4	0.685938	0.0099	-458.315857	3609886.158
Segment 4	0.869062	0.005571	-292.470612	3610185.968
Segment 4	0.985781	0.007942	-282.803925	3610998.688
Segment 4	1.287344	0.015465	-277.382233	3611765.113
Segment 4	0.679375	0.004826	-173.469894	3613059.463
Segment 4	0.679375	0.00486	-176.165375	3613071.963
Segment 4	3.439688	0.041663	-322.383118	3613589.899
Segment 4	0.640469	0.008554	-235.56311	3613831.864
Segment 4	0.883281	0.006111	-148.169754	3614884.867
Segment 4	6.589062	0.073713	-202.826889	3617049.734
Segment 4	2.469844	0.038263	-244.828995	3617976.37
Segment 4	2.035781	0.013028	-406.35672	3619192.667

Segment 4	1.293438	0.007526	-220.238602	3619787.41
Segment 4	1.2575	0.01692	-440.557343	3620334.943
Segment 4	0.687344	0.003839	-478.787811	3620967.228

A GIS polygons database of the above listed scars will be provided.

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4. Figure captions:

Figure SI1: The digital elevation model (DEM) of the continental slope offshore Israel, compiled from the collective integration of the available data sets. Locations of the data sets are delineated by red polygons and red numbers, detailed in Table 1SI. White numbered lines mark the locations of seismic profiles displayed in the supplementary.

Figure SI2: TGS 2D time migrated seismic section approximately 7 X vertically exaggerated (for location see figure 1SI). Lenticular depositional lobe of chaotic seismic facies, bounded by a blue and orange lines, correlate to a bathymetric bulge C1. The basal surface of the lobe (orange) is traced upslope to a headwall overlaying normal faults rooted in Pliocene-Quaternary sediments (black lines).

Figure SI3: TGS 2D time migrated seismic section approximately 6 X vertically exaggerated (for location see figure 1SI). Lenticular depositional lobe of chaotic seismic facies, bounded by a blue and orange lines, correlate to a bathymetric bulge C1, which its downslope termination overlays a seafloor incising graben (black lines). The basal surface of the lobe (orange) is traced upslope to a headwall overlaying a normal fault (black lines). B) The same seismic profile flattened to the seafloor horizon, showing a divergent sigmoid sedimentary pattern overlaying the basal surface upslope location (labled).

Figure SI4: A) TGS 2D time migrated seismic section approximately 8 X vertically exaggerated (for location see figure 1SI). Lenticular depositional lobe of chaotic seismic facies, bounded by a green and yellow lines, correlate to a bathymetric bulge

C2, which its downslope termination is followed by a seafloor incising graben (black lines). The basal surface of the lobe (yellow) is traced upslope to a headwall. B) Sea-floor flattened version of the seismic section showing a divergent sigmoid sedimentary pattern overlaying the basal surface upslope location.

Figure SI5: TGS 2D time migrated seismic section approximately 10 X vertically exaggerated (for location see figure 1SI). A Lenticular depositional lobe of chaotic seismic facies (marked with yellow and green) correlated with the C3 bulge. The BSS is traced upslope to a headwall.

Figure SI6: TGS 2D time migrated seismic section approximately 20 X vertically exaggerated (for location see figure 1SI). A Lenticular depositional lobe of chaotic seismic facies (marked with yellow and green) correlated with the C3 bulge. An overlaying 10^3 m scale open slope slide debris (black).

Figure SI7: TGS 2D time migrated seismic section approximately 20 X vertically exaggerated (for location see figure 1SI). A Lenticular depositional lobe of chaotic seismic facies (marked with yellow and green) correlated with the C3 bulge.

Figure SI8: METEOR 2D single channel time seismic section approximately 6 X vertically exaggerated (for location see figure 1SI). A Lenticular depositional lobe of chaotic seismic facies (marked with gray and green) correlated with the C3 bulge. Overlaying 103 scale open slope slide debris marked with orange and purple.

Figure SI9: METEOR 2D single channel time seismic section approximately 25 X vertically exaggerated (for location see figure 1SI). A Lenticular depositional lobe of chaotic seismic facies (marked with gray and green) correlated with the C3 bulge. Overlaying 103 scale open slope slide debris marked with orange and purple.

Figure SI10: TGS 2D time migrated seismic section approximately 10 X vertically exaggerated (for location see figure 1SI). Lenticular depositional lobe of chaotic seismic facies, bounded by a blue and red lines, correlate to a bathymetric bulge C4. The basal surface of the lobe (red) is traced upslope to a headwall overlaying a normal fault (black lines). An overlaying 10^3 m scale open slope slide headscarp is also labeled.

Figure SI11: TGS 2D time migrated seismic section approximately 10 X vertically exaggerated (for location see figure 1SI). Lenticular depositional lobe of chaotic seismic facies, bounded by a blue and red lines correlate to a bathymetric bulge C5. The basal surface of the lobe (red) is traced upslope to a headwall overlaying normal faults (black lines). An overlaying 10^3 m scale open slope slide headscarp ls labeled.

Figure SI12: TGS 2D time migrated seismic section approximately 20 X vertically exaggerated (for location see figure 1SI). Lenticular lobes of chaotic seismic facies are marked at the locations of C5-C7 bathymetric bulges.

Figure SI13: Estimation of long-term bathymetric profiles based on Hübscher, et al., (2016) interpreted seismic sections across the continental slope offshore Israel. The left panels a-c display the color-coded interpreted stratigraphic sequences from Hübscher, et al., (2016) figures 3-5, respectively. The right panels display the sequence tops in corresponding colors (gray, blue and red curves) after vertical and horizontal shifting to overlay the seafloor (green), overlain by the averaged long-term profiles (black). See text for explanation of the procedure.