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Ancient record of changing flows from wave ripple defects

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SUPPLEMENTARY FIGURES, TABLE, AND MOVIE CAPTIONS

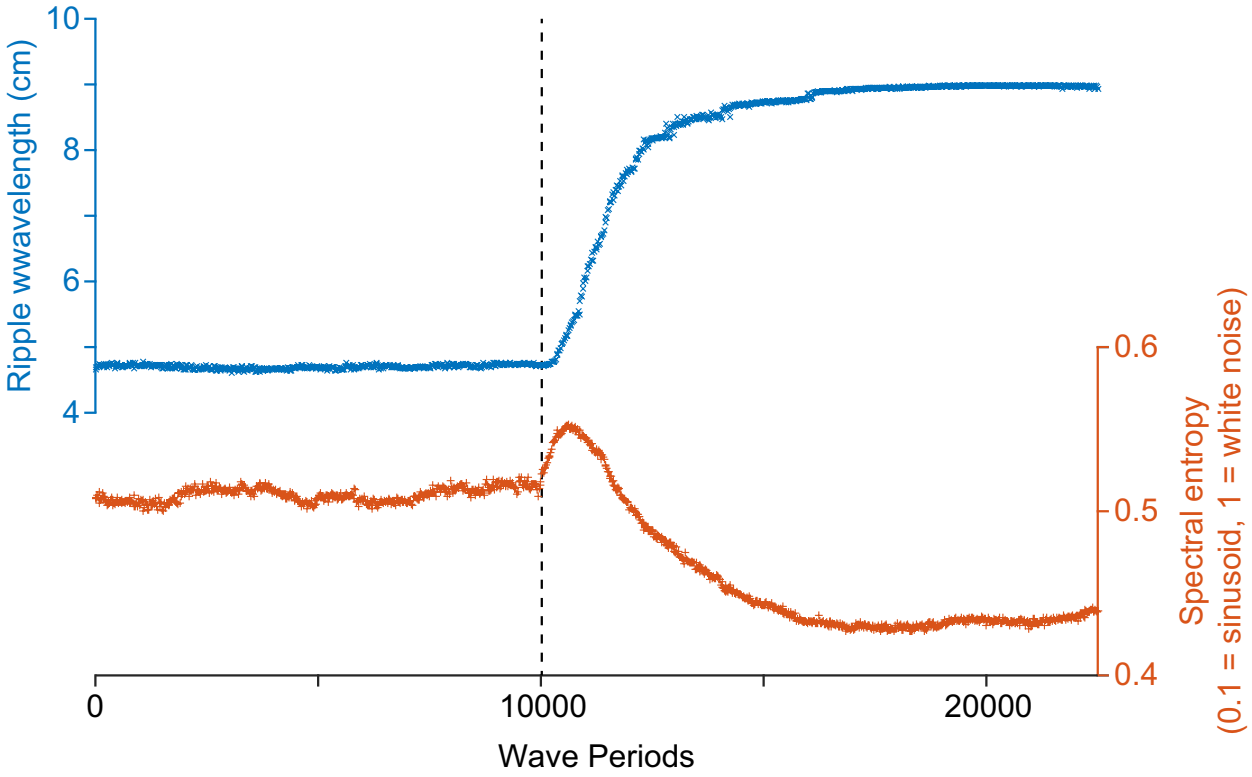

Figure DR1. Timeseries of ripple wavelength and normalized spectral entropy for experiment 20120316, in which wave conditions and bed evolution were similar to the experiment shown in Figure 2A-D and Movie DR2. Dashed line marks the change in wave conditions. The difference in average spectral entropy before and after the change in wave conditions is due to a correlation between ripple wavelength and entropy.

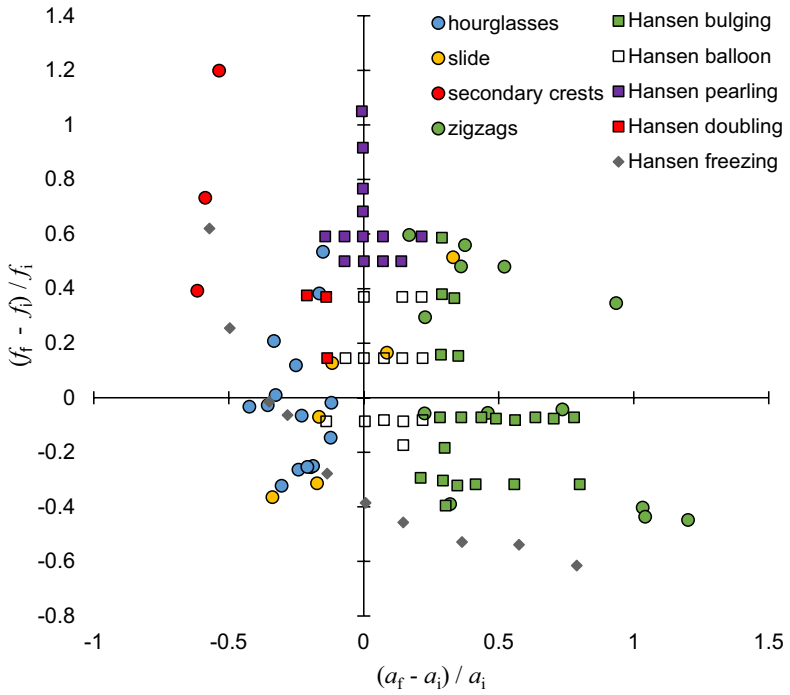

Figure DR2. Occurrence of different types of two-dimensional wave ripple defects as a function of fractional change in flow oscillation frequency *f* and fractional change in flow orbital amplitude *a* in our wave tank experiments (circles) and the oscillating tray experiments of Hansen et al. (2001a) (squares). Subscripts refer to the conditions before (i) and after (f) the change in flow. Like colors indicate defect types that are compared in the main text. The comparison reveals several similarities and differences. First, bulging and zigzags overlap in this parameter space, suggesting that they are similar phenomena. Second, our slide experiments cross Hansen's stability balloon, indicating that we observe changes in ripple spacing under conditions for which they did not. Third, secondary crests and doubling do not overlap in this parameter space, suggesting that they may be different phenomena; rather, Hansen's doubling experiments overlap partially with our hourglass experiments, despite the different appearance of those defects. Fourth, pearling occurs when there is an increase in frequency but little to no change in amplitude – conditions that typically do not occur in nature – suggesting that pearling is a different phenomenon than hourglasses.

Table DR1. Summary of experimental data.

Experiment	Initial spacing, λ_i (cm)	Final spacing, λ_f (cm)	$(\lambda_f - \lambda_i)/\lambda_i$	Dominant defect	Dominant defect duration (hr)	Dominant defect duration (wave periods)
20110214	8.0	7.0	-0.12	hourglass	11.9	17563
20110215	4.5	7.7	0.69	zigzag	1.3	1944
20110216	9.0	7.2	-0.20	hourglass	4.4	6571
20110217	8.4	7.6	-0.10	hourglass	5.8	8902
20110225	5.8	7.1	0.21	slide	3.4	5965
20110226	8.5	6.7	-0.21	hourglass	3.8	6747
20110227	7.2	8.3	0.14	slide	11.7	15902
20110228	8.4	7.4	-0.12	hourglass	8.2	11330
20110301	10.0	7.4	-0.26	hourglass	5.7	7918
20110302	8.9	7.4	-0.17	hourglass	4.1	6999
20110303	5.5	7.8	0.41	zigzag	2.0	3553
20110308	6.0	7.3	0.22	zigzag	1.2	1977
20110309	7.1	7.3	0.03	zigzag	4.3	7352
20110314	9.6	8.9	-0.08	hourglass	15.9	18280
20110315	9.0	8.5	-0.05	hourglass	14.2	16579
20110316	7.2	7.9	0.10	slide	12.7	14812
20110317	6.1	6.5	0.07	zigzag	7.4	8581
20110503	8.1	8.6	0.05	slide	9.7	11040
20110504	4.7	7.6	0.62	zigzag	3.0	3900
20110506	10.3	10.8	0.05	slide	9.2	10460
20110507	5.7	7.0	0.22	zigzag	3.9	6300
20110508	9.1	7.1	-0.21	hourglass	9.1	12100
20110510	6.8	7.5	0.10	zigzag	2.2	3120
20110511	8.8	7.8	-0.12	hourglass	14.5	18260
20110512	9.1	8.1	-0.10	slide	10.5	13280
20110513	9.2	7.6	-0.18	hourglass	10.0	12720
20110515	11.0	8.0	-0.27	hourglass	8.0	10000
20110516	5.2	7.6	0.45	zigzag	5.7	6820
20110517	6.2	7.4	0.21	zigzag	3.8	4680
20110518	9.8	8.0	-0.18	hourglass	11.7	15640
20120303	10.6	5.1	-0.52	sec. crest	2.4	5420
20120308	8.8	4.9	-0.44	sec. crest	2.4	5420
20120312	8.9	4.7	-0.47	sec. crest	2.2	4920
20120314	4.6	10.6	1.29	zigzag	3.0	3840
20120316	4.7	8.9	0.90	zigzag	3.9	4840
20120320	4.4	8.9	1.02	zigzag	5.7	7460

Movie DR1. Wave tank during an experiment.

Movie DR2. Time-lapse animation of part of experiment 20120320 (Fig. 2A-D). Each second in movie corresponds to 7 minutes of real time. Change in flow orbital diameter occurs 10 seconds into movie. Height of frame is 56.6 cm.

Movie DR3. Time-lapse animation of part of experiment 20110216 (Fig. 2E- H). Each second in movie corresponds to 15 minutes of real time. Change in flow orbital diameter occurs 10 seconds into movie. Height of frame is 51.5 cm.

Movie DR4 Part 1. **Movie DR4 Part 2.** Time-lapse animation of part of experiment 20120312 (Fig. 2I-L). Each second in movie corresponds to 4 minutes of real time. Change in flow orbital diameter occurs 10 seconds into movie. Height of frame is 56.8 cm.

Movie DR5. Time-lapse animation of part of experiment 20110510 (Fig. 1H) showing an edge dislocation propagating from left to right. Each second in movie corresponds to 25 minutes of real time. Height of frame is 56.4 cm.