THE SHAPE OF EROSIONAL ARCTIC SHOREFACE PROFILES

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The shape of 63 shoreface profiles along erosional Arctic coasts (Fig. 1) is investigated and compared with the shape of shoreface in temperate environments in order to identify differences caused by Arctic cryogenic processes. Two mathematical expressions were chosen for description of profiles:

(1) power function suggested by Bruun (1954)

$$h = -A \cdot x^{m},$$

where h is water depth, x is offshore distance from the shoreline, A is sediment scale parameter, and m is profile shape factor;

(2) exponential function suggested by Bodge (1992)

$$h = -B(1 - e^{-kx}),$$

where B is an asymptotic depth at a great offshore distance, and k is decay constant.

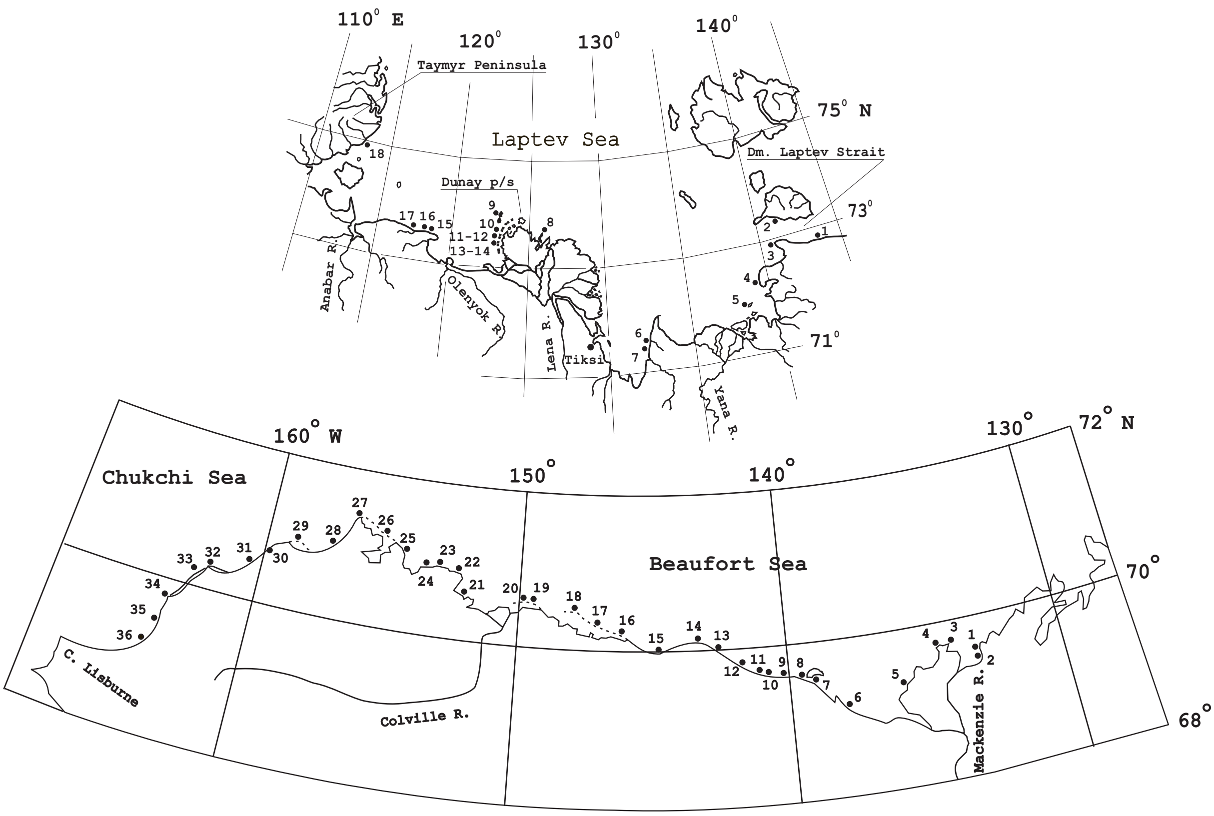

Figure 1. Location of the shoreface profiles investigated.

The shoreface outer boundary position was identified visually on profile diagrams by a change of sea floor slope. This change could be recognized with confidence on most profiles. Especially clear break of slope takes place in shallow seas like Laptev Sea or eastern part of Beaufort Sea. However, the change of slope is often not sharp enough to be generally agreed upon, leaving a questionable transition zone between shoreface and shelf. Therefore, having altogether 63 profiles, we made over 200 fits trying different parts of profiles.

The Grapher 3.0 software of Golden Software, Inc. was used to find the best fits for all profiles. Generalized results of the fitting are presented in Table 1.

The numbers in Table 1 show that

(1) All shape parameters ***m*** and ***A*** of Arctic profiles are in the range, obtained outside of the Arctic.

(2) The ranges of average ***m*** values for Arctic (0.42 - 0.68) and non- Arctic profiles (0.4 - 0.67) almost coincide.

It means that shoreface profiles in the Arctic and in the mid- and low latitudes have generally the same shape, despite the fact that cryogenic processes influence the Arctic shoreface morphology in several ways. Evidently the changes of the shoreface profile shape caused by cryogenic processes are short-lived because the storms restore the equilibrium profile.

Table 1

Coastal section	Number of profiles	**A**			***m***		
		Min.	Average	Max.	Min.	Average	Max.
Three Arctic Seas	63	0.007	0.36	2.43	0.24	0.52	1.00
Laptev Sea, all	18	0.008	0.32	1.38	0.27	0.58	0.81
Laptev Sea, ice complex coasts	9	0.008	0.12	0.81	0.34	0.68	0.81
Laptev Sea, sand coasts	7	0.054	0.37	0.77	0.30	0.51	0.76
Chukchi Sea	10	0.043	0.32	1.63	0.27	0.57	0.73
Beaufort Sea, Alaska	16	0.007	0.46	2.43	0.24	0.48	0.85
Beaufort Sea, Canada	19	0.017	0.46	0.88	0.25	0.42	1.00
U.S Atlantic and Gulf coasts after Dean (1977)	504	0.0025		6.31	0.1	0.67	1.4
Bass Strait, Australia after Wright et al. (1982)						0.4	
U.S. Pacific, San Diego region, after Inman et al. (1993)						0.4	
Caribbean beaches after Boon and Green (1988)						0.5	

All investigators of the shoreface profile shape aimed at obtaining average values of profile shape factor *m*. Dean, who had analysed 500 profiles along the U.S. Atlantic coast, found average *m* = 0.67 and adopted to use this value as a constant.

Histogram for all 63 Arctic profiles we have (Fig. 2), as well as some other histograms for particular seas and different coastal geology show that distribution of *m* values is rather far from normal Gaussian distribution. The predominance of average *m* is poorly expressed. Only about 8-10 % of profiles is characterised by average *m*. Actually prevail *m* values less than average value 0.52. On the whole our data lead to conclusion that the shape of Arctic shoreface profiles is highly variable and cannot be characterised by whatever average *m* even for geologically uniform erosion coasts.

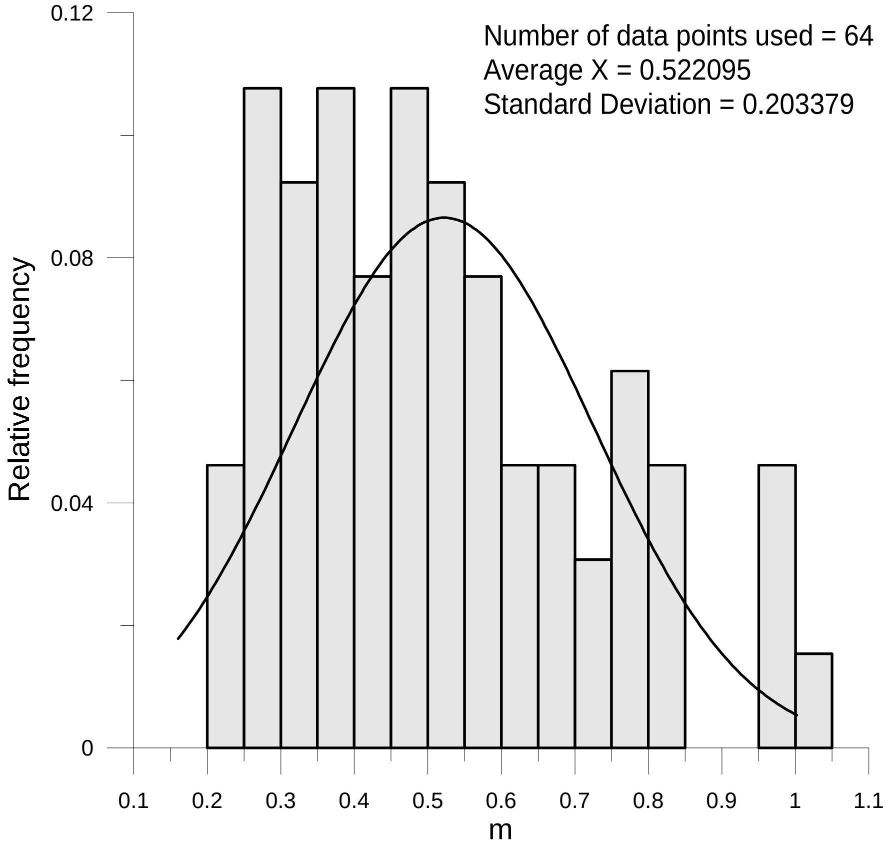

Figure 2. Histogram of the profile shape factor *m* values from 63 Arctic profile fits.

It is generally recognised, that shoreface shape reflects the interaction of environmental forcing and coastal material. The sediment scale parameter *A* in the Bruun power function is controlled by sediment grain size, and profile shape factor *m* reflects the wave energy dissipation on the shoreface. Therefore a functional dependence between these two parameters has to exist. Processing the data at our disposal showed that this is true indeed. The diagram in Fig. 3 clearly reveals an inverse reliance between ***m*** and ***A***. Existence of this reliance demonstrates that trying to find any average of ***m*** value, defining shoreface profile shape is senseless. All the more unacceptable is to use a constant ***m*** for general description of the shoreface profile shape. A constant ***m*** would mean constant ***A***. But according to Fig. 3, it is possible only for a particular combination of bed material and environmental forcing. Correspondingly the shoreface profile shape along any coastal section characterised by certain geological and hydrodynamical conditions may be described by a definite combination of ***m*** and ***A*** values.

Comparison of Bruun's power function and Bodge exponential function fits to Arctic shoreface profiles do not support advantage of exponential function revealed by Bodge (1992). In general power function fits Arctic profiles better. But the difference in fit quality is small. The general divergence of R^2 values for two functions equals 1.6 %. However, exponential function fits better the upper parts of profiles.

Bodge assumption about using parameter ***B*** from exponential function to define closure depth and thus to locate the shoreface outer boundary position did not find confirmation in this study.

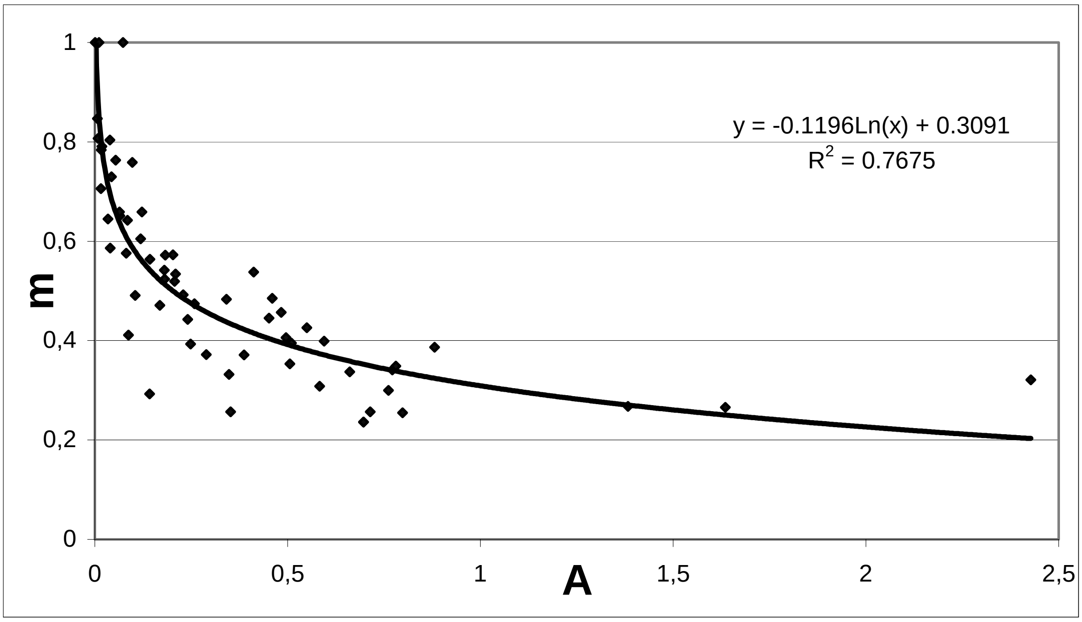

Figure 3. Relationship of sediment scale parameter *A* and profile shape factor *m*.

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