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# Toward a Classification of Beach Profiles[1]

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**ABSTRACT**

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**This is a taxonomic system supported by two basic data sets: morphology and genetics. The morphological basis is the notion of *sequence* or set of elements whose combination defines a simple profile as a whole. There are two kinds of sequences: beach profile and berm or ridge profile. A beach profile (*sensu stricto*) is formed by the couplet "beach face – upper beach" and a berm or ridge profile is formed by the couplet "beach face – backshore." Whole profiles are classified according to number of sequences into single, double, and multi-sequences. The genetic basis is the *process*, and then profiles are classified into accretional, erosional, and mixed categories. The name of each group results from a combination of a number of sequences and processes. The empirical support of the classification is represented by 380 profiles surveyed along 413 km of coastline in central Chile. The number of identified groups partly depends on the observed coastal environment. Groups are hierarchically placed into categories according to the kind and number of sequences and the processes, respectively.**

**ADDITIONAL INDEX WORDS:** *Accretion, accretional profile, beach, beach erosion, beach processes, beach ridge, erosional profile, mixed profile, taxonomy of beach profiles*

## INTRODUCTION

### Previous Work

Relatively few works deal with beach profile taxonomy. SAVILLE (1950) distinguishes two types of beach profiles: storm profiles and summer profiles. SHEPARD (1950) divides the Pacific coast profiles into two categories: winter or concave-up profiles and summer or concave-down profiles. But, as DAVIS (1982) argues, common reference to seasonal classification is exposed to misinterpretations. In fact, frequent variations in wave energy on the Atlantic coast of the United States "may overshadow any seasonal variations in wave climate" (HAYES and BOOTHROYD, 1969, cited in BRENNINKMEYER, 1982).

Therefore, a genetic terminology is subsequently preferred. In this way, the COASTAL ENGINEERING RESEARCH CENTER (1973) places beach profiles in two categories: *erosional* (storm profile) and *accretional*.

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### The Problem

In spite of the clarity of the Coastal Engineering Research Center's classification, field experience in central Chile shows that there are simple, compound and complex profiles, which can be composed both of erosional and accretional parts. At the same time, some works (DAVIS, 1957, GEIJSKES, 1952, PSUTY, 1967) distinguish between beach formation along a continuously accreting beach and formation in an accreting beach being accompanied by intermittent retreat. These possible trends are the product of an erosion-depositional couplet which is present in two spatial and temporal scales: the tidal cycle and seasonal storms (BRENNINKMEYER, 1982). But the distribution of storms is not necessarily cyclic and storm profiles are not always synonymous with erosional profiles, because field experience shows sometimes these are accretional parts of the profile corresponding to storm impact.

### Present Purpose

The proposed classification should be both morphological and genetic. Each category should specify a combination of forms and elements, whose structure should recognize recent and present trends and alternations of processes. Therefore, it is proposed that profile classification should provide information for changing and evolving beaches.

Moreover, following PSUTY's (1965) distinction between *active* and *inactive* systems in profiles, it should generally be possible to recognize such systems, whenever different parts of profiles are clearly specified and well studied. Therefore, different categories of profiles should represent certain combinations of events, whose spatial and temporal sequence cannot be specified using existing classifications.

## METHODS, TECHNIQUES, MATERIAL STUDIED AND AREA

The morphological and genetic data are expressed as follows:

From the morphological point of view the system is based on the notion of a *sequence* or set of morphological elements whose combination defines a simple profile as a whole. In this way, a single set of beach face and backshore is a sequence; this is a couplet, in the same way as the couplet "plage" and "haut plage" appears in the French nomenclature. But, in order to determine more accurately the genetic significance of sequences, the couplets beach face – backshore and "plage" – "haute plage" will not be used as synonyms. The couplet beach face – backshore will be used only in the case of *berm or ridge sequence* (*sensu stricto*), that is to say, if the inner face slopes landward, according to the general usage in the Anglo-Saxon literature. On the other hand, the couplet "plage" – "haut plage" will be used in reference to the *beach sequence* (*sensu stricto*), that is to say, if the "haut plage" slopes seaward or is closer to the horizontal, without sloping landward. Thus, a sequence may be a beach or a berm ridge profile. Whole profiles are classified according to the number of sequences into *single*, *double*, and *multi-sequences*.

From the genetic point of view this follows the criterion of the COASTAL ENGINEERING RESEARCH CENTER (1973) but adds the *mixed* category. Accordingly, three groups are distinguished: *accretional*, *erosional*, and *mixed*.

Field observations suggest that convex elements are accretional evidence, whereas concave elements are erosional. Moreover, morphogenetic sequences interpreted from beach and beach ridge stratification (PSUTY, 1967) indicate intermittent accretion and retreat that leads to the development and abandonment of a berm ridge, and thereby produces successively convex elements developed after wave action by long steep waves, and concave elements after wave action by short steep waves. The erosive action of the latter is shown by a considerable reduction of size of the swash bar. Therefore, the following definitions are proposed:

An *accretional profile* is formed by convex-concave elements, an *erosional profile* is formed by concave elements, and a *mixed profile* is formed both by convex and concave elements.

The empirical basis for the classification is obtained from studies of the central Chile coastline, where the spring tide range is medium to low (1.3 to 1.8 m). The wave environment is of high to medium energy. The significant wave height ranges from 0.8 to 2.2 m more than 40% of the time. Waves are higher than 2.4 m for 30 to 40% of the time during the winter half of the year, and 3% of the waves during the winter season have heights between 3.6 and 4.9 m. The mean wave period for ocean swell is 12 seconds. During surges, there are periods of 15 to 20 seconds, or as much as 50 to 100 seconds, in the presence of surf beat (ARAYA-VERGARA, 1981).

In this coastal environment, 380 beach profiles were surveyed along 413 km of coastline. Each survey was conducted employing the pole and horizon technique, by using tape measure and Brunton compass. Each profile was drawn directly from nature to a scale of 1:500 on a standard field card. In order to understand the temporal significance of profiles, the following data were registered on each card: time, tidal phase, sea condition (state), type of breaker, alignment, and kind of attack condition of each element, considering tidal phase and surge events. Inasmuch as classes were established, *prototypes* were selected in order to represent each group (Figures 1 and 2). Finally, a hierarchical arrangement of the categories was established using the principles established by ARAYA-VERGARA (1977). The classes were formed on the basis of kind and number of sequences and the difference of process.

## RESULTS

The name of each group results from the combination of sequences and processes (Table 1, Figures 1 and 2).

The number of sequences shows limited groups (landforms) for single and double-sequences because the theoretical number of combinations equals

Table 1. Classification of Beach Profiles.

| Number and Kind of Sequence | Process | | |
|---|---|---|---|
| **Single-Sequence** | Accretional | Erosional | Mixed |
| Beach ("Plage"-"Haute Plage") | – Convex-concave beach | – Concave beachface and "Haute Plage"<br>– Concave beachface and cliffed dune | – Convex-concave beach and cliffed dune<br>– Cliffed convex-concave beach |
| Ridge (Beachface-Backshore) | – Convex-concave ridge | – Concave beachface ridge<br>– Concave beachface ridge and dune cliff<br>– Biconcave ridge and cliffed dune | – Convex-concave ridge and cliffed dune<br>– Convex-concave ridge and cliffed beachface |
| **Double-Sequence** | | | |
| Double beach | – Double convex concave beach | – Double concave beach | – Double convex-concave beach and cliffed dune |
| Outer ridge and inner beach | – Convex concave ridge and "Haute Plage" | – Biconcave ridge and concave beach<br>– Concave ridge and cliffed "Haute Plage" | – Concave ridge and convex "Haute Plage"<br>– Convex ridge and concave "Haute Plage" and cliffed dune |
| Outer beach and inner ridge | – Convex concave beach and ridge | – Concave beach and ridge | – Convex-concave beach and ridge and cliffed dune<br>– Cliffed "Haute Plage" and convex ridge<br>– Convex-concave beach, concave ridge and cliffed dune. |
| Double ridge | – Double convex-concave ridge | – Double concave ridge | – Outer concave ridge and inner convex ridge<br>– Outer convex ridge and inner concave ridge<br>– Double convex-concave ridge and cliffed dune |
| **Multi-Sequence** | | | |
| Double outer ridges and inner beach | – Double convex concave ridge and beach | | – Outer convex ridge, inner concave ridge and convex beach |
| Double outer beach and inner ridge | – Double convex concave beach and ridge | | |
| Outer and inner beaches and one middle ridge | – Outer and inner convex concave beaches and middle convex ridge | | |
| Outer beach and two inner ridges | – Convex outer beach and two convex inner ridges | | – Outer convex beach and two concave ridges<br>– Outer convex beach, two inner convex ridges and cliffed dune |
| Outer and inner beaches and two middle ridges | – Outer and inner convex beaches and two middle convex ridges | | |
| Three ridges | – Three convex ridges | – Three concave ridges | – Outer convex ridges and inner concave ridge<br>– Outer concave ridge and inner convex ridges<br>– Outer and inner concave ridges, middle convex ridge and cliffed dune |
| More than three ridges | – Convex multisequence | – Biconcave and concave multisequence | – Convex-concave alternate multisequence |

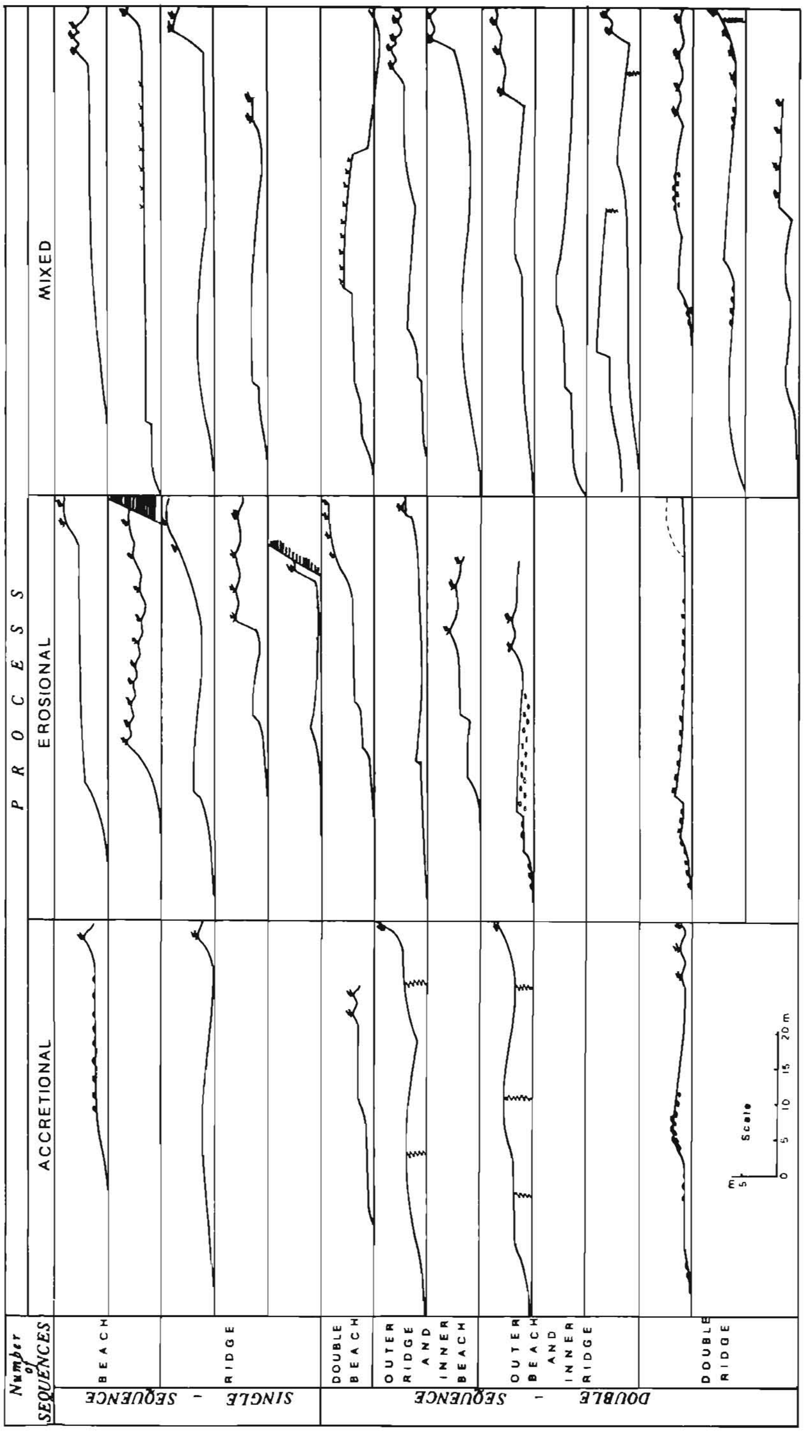


Figure 1. Classification of Beach Profiles.

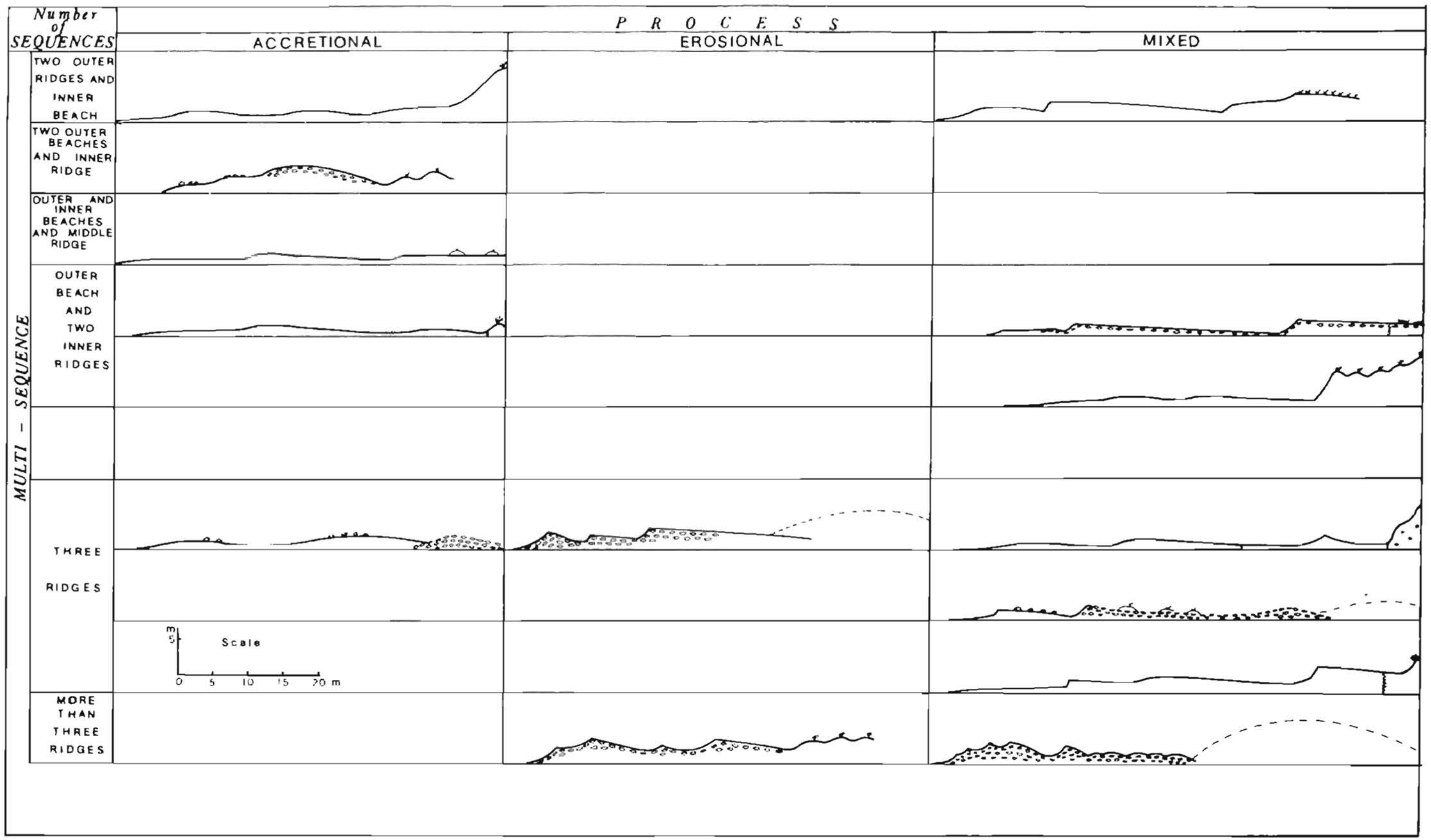


Figure 2. Classification of Beach Profiles.

Table 2. Frequence of Taxonomic Groups for Beach Profiles

| Number of Sequences | % | Number of Processes | % |
|---|---|---|---|
| Single-sequence | 15 | Accretional | 29 |
| Double-sequence | 31 | Erosional | 27 |
| Multi-sequence | 54 | Mixed | 44 |

experienced cases. At the same time, the number of groups for the multisequence is possibly incomplete because all theoretical possibilities are not experienced. The number of groups derived from different processes is complete in the accretional single and double sequences because all theoretical possibilities are realized. However, the number of other groups is generally incomplete, especially for the mixed groups and multi-sequences.

Groups that were actually observed include 13 kinds of sequences and 45 cases of process. Table 2 shows that the greatest number of cases is mixed.

In order to illustrate the use of the classification as an analytical tool, the multi-sequential category composed of *three ridges* and its first three cases (Figure 2) will be reviewed. The *accretional* case shows three convex ridges and is therefore indicative of a continuously accreting beach. The *erosional* case shows three concave ridges that are followed by an accreting trend which is accompanied by intermitent retreat. Finally, the corresponding *mixed* case shows two external convex ridges and one internal concave ridge. This sequence is interpreted as representing a former accreting beach interrupted by an erosional oscillation that was then followed by a continuously accreting trend. In this example, the term "beach" is used *sensu lato* and the terms accretional, erosional, and mixed are employed as substantivized adjectives.

## DISCUSSION AND CONCLUSIONS

In spite of the unstable character of a part or all of the profile, its classification and analysis are seen as an inseparable operation. The classic subdivision of beach profiles seems inadequate because it concerns a single morphological sequence that is related to the tidal cycle. Compound and complex profiles, on the other hand, seem to be related to storm surge oscillations.

Even though classification and analysis incorporates recent sequences and oscillations, it is difficult to recognize the presence of active and inactive systems in multisequences, as established previously by PSUTY (1967) and elucidated in the analysis of the example provided in this paper. It is suggested that careful observations in the field might provide a basis for recognizing overprinting of oscillations on top of trends. In some cases, however, it is difficult to know if some profile elements are manifestations of trends or oscillations, according to TRICART's (1965) concept.

A key step in using profiles to recognize trends and oscillations is to distinguish between morphological sequences and microrelief. As TRICART (1965) states, during any particular morphogenetic sequence there is not only an important threshold but also small modifications that occur during the relaxation phase. There are several factors that can support changes in intensity and direction. These changes are, however, smaller oscillations that correspond to a smaller order of size being represented by microrelief. Unfortunately, it is not always possible to separate microrelief from sequences as it occurs with some microcliffs on beach faces. Thus, both sequences and microreliefs may correspond to oscillations and not necessarily to general trends.

The number of groups in the present classification depend partly on the empirical basis of observation, the actual coastal environment. New groups will, no doubt, be recognized in other environments. Consequently, the proposed scheme must be open-ended to incorporate new groups as occurs in other scientific classifications.

The range of possible groups must always be combinations of sequences or sections of beaches and ridges whose profiles must be defined *sensu stricto* in order to facilitate the morphological decription using this classification. It is stressed that the difference between a backshore sloping landward and a "haute plage" sloping seaward has a genetic connotation both for taxonomy and analysis. Finally, the predominance of multi-sequential categories and the high frequency of mixed cases demonstrate that a number of individuals need be classified within a taxonomic system in agreement with morphogenetic sequences as they occur in nature.

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