

Littoral carbonates of south-west England: preliminary observations on mineralogy and geochemistry

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Introduction

This work forms part of a continuing programme of mineralogical and geochemical investigations on Recent sediments of south-west England. Reported in this note are some preliminary observations on cool-water carbonates (topic recently reviewed by Leonard and others 1981). Littoral sediments of the coast and estuaries have been collected to provide a systematic geographical cover of the area. The sand/silt fraction ($< 250\mu\text{m}$) is presently under examination. It is hoped that information gained in mapping the carbonate-sands will also provide useful data on sediment source and transport.

Method

Active sediment has been sampled at high and low water level of coastal sampling stations, wet-sieving and dry-grinding techniques have been used to provide powder for mineralogical and chemical analyses. Acetic acid digests (IN) were made to dissolve skeletal material and provide data on percentage total carbonate. Magnesium and Sr were analysed on the leachate by flame emission. Carbonate mineralogy has been determined by X-ray diffraction using standard mixtures of biogenic calcite and aragonite. A dolomite standard (G.F.S. 400) has been used to estimate dolomite when present. Staining techniques are to be employed in an attempt to assess relative contributions of Recent biogenic and fossil carbonates to the total.

Carbonate percentages

In the modern beach sand, carbonate percentages given from the average of high and low water level samples, show a considerable range (Fig. 1). Values on the north coast, with the exception of Godrevy, are particularly carbonate-rich (ave. 34% carbonate). Carbonate concentrations from the lower Taw (30%), Camel (54%) and Hayle (61%) estuaries support this. Beach sand at Godrevy, however, proves anomalous having a carbonate fraction of 16% and considerable heavy mineral concentration of 27%. Along the north Cornish and Devon coast, quantitative mineralogical analyses of non-carbonate material (Stuart and Simpson 1936) has shown that shore sands correlate well with local sources.

Large quantities of tailings from the Camborne/Redruth mining area, transported to the beach by the Red river are swept across it by successive tides. The resulting tabling action is able to concentrate heavy grains (Hosking and Ong 1963).

On the south-west corner of the south coast carbonate-rich sands occur at Praa (41%), but elsewhere eastwards, values are generally lower and average at 13% carbonate. Lowest value recorded is at Exmouth (2%) where erosion of New Red Sandstone material prevents a significant build-up of biogenic debris.

Carbonate mineralogy

Aragonite contributes 46% (ave. 20 samples) to the total carbonate fraction whilst low-magnesium calcite at 47% is a little in excess (Table 1). This might be expected as pelecypods are probably the major benthic carbonate contributors to modern shallow-marine sediments (Milliman 1974), with shells that are mainly aragonite or contain a mixture of aragonite and calcite. Littoral sediments examined adjacent to Pleistocene raised beaches of south-west England (West 1973) yielded total carbonate contents of 44% with low magnesium calcite values about twice those of aragonite. The calcite raised beaches, therefore, might possibly contribute significant quantities of calcite to modern beach material. High-magnesium calcite occurs with a concentration of about 7%.

However, from Table 1 it is noticeable that no high-magnesium calcite has yet been detected on the south coast. Detrital dolomite has been recognised in some coastal samples at about 2%.

Carbonate geochemistry

It has long been known that Sr substitutes for Ca in aragonite and to a lesser extent calcite (Noll 1934), and conversely that Mg concentrations in biogenic calcite are greater than in aragonite (Clarke and Wheeler 1922). In the temperate-water bryozoan sands of Tasmania, which are predominantly calcitic, Sr content has been directly linked with increase in aragonite (Rao 1981). Analyses of

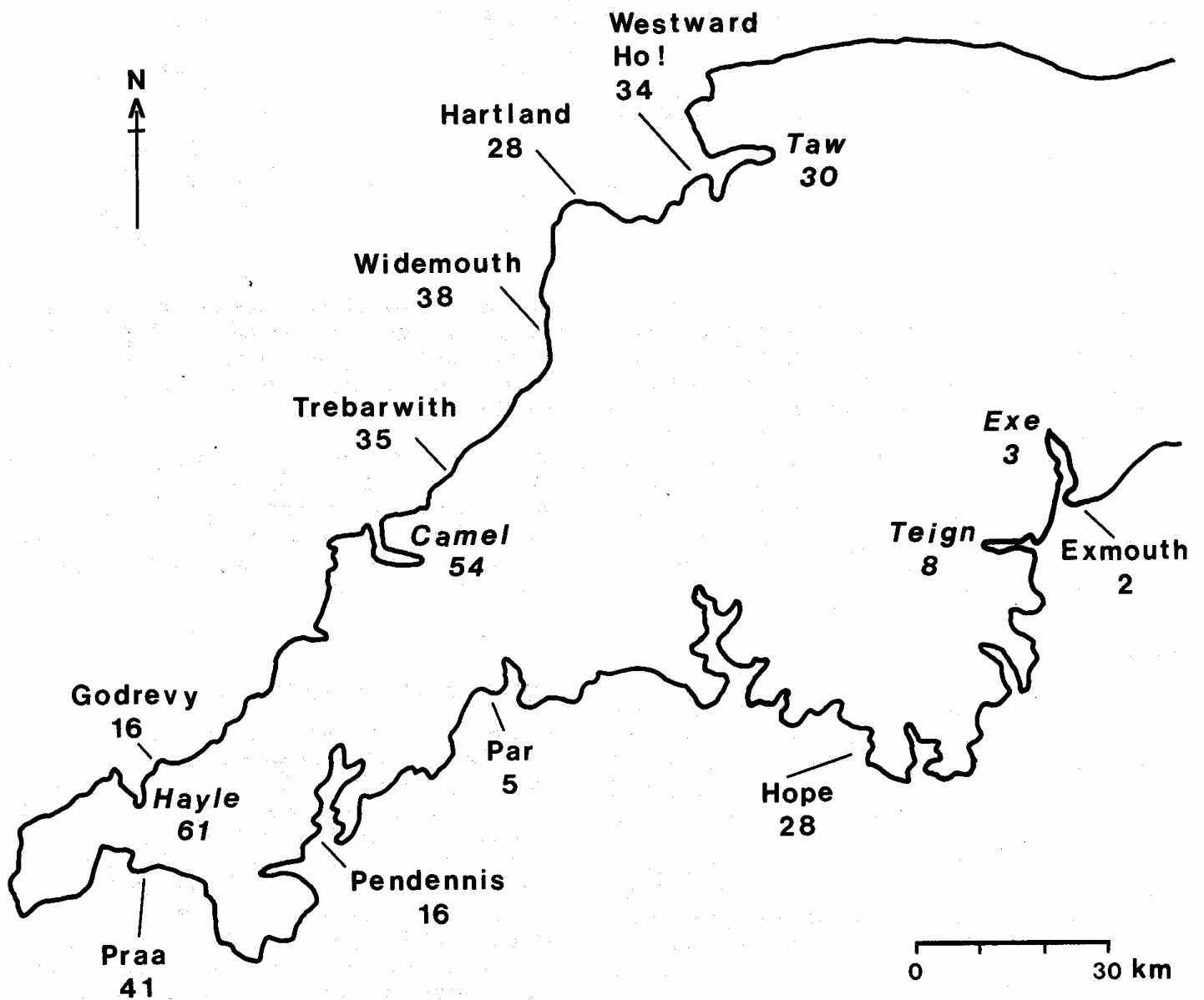


Figure 1. Percentage total carbonate of littoral sediments of south-west England. Values in italics are carbonate concentrations from lower parts of the named estuaries.

such elements, therefore, can provide information on both the amount and character of skeletal debris present in marine-derived sediments. This is particularly useful where carbonate concentrations are low and mineralogical determinations difficult.

Carbonate and Sr concentrations in the Hayle, Camel and Taw estuaries (30-60% carbonate; 7000-12000ppm Sr) greatly exceed those of the Teign and Exe (3-8% carbonate; 50-70ppm Sr) examined in the south (Merefield 1978; 1981). Geochemical results of north coast estuaries with high amounts of carbonate persisting landward also demonstrate that marine-derived material is transported relatively, farther up-estuary. Thus a multi-stage mechanism is envisaged whereby marine sediments deposited initially in the lower estuary provide a supply of material for subsequent up-estuary transport.

Table 1. Carbonate mineralogy of modern beach sands of south-west England.

Locality	Aragonite	Low-Mg Calcite	High-Mg Calcite	Dolomite
	%	%	%	
Westward Ho!	27	50	23	-
Hartland	54	34	12	d
Widemouth	60	30	10	d
Trebarwith	51	40	9	d
Godrevy	37	50	13	-
Praa	42	58	-	-
Pendennis	77	23	-	-
Par	58	42	-	-
Hope	55	45	-	d
Exmouth	-	100	-	-

Values expressed in per cent of the carbonate fraction are from X-ray diffraction, d: detrital dolomite present.

Deductions

Differences in carbonate mineralogy and geochemistry between estuarine and shore samples of north and south coasts demonstrate the role a supply of siliceous material performs in limiting carbonate concentrations. Biogenic debris on the easterly shore section of the south coast is prevented from reaching the amount present in the north owing to a high production of New Red Sandstone detritus.

The fairly equal distribution of aragonite and calcite from the present work contrasts with that of sub-tropical environments where aragonite clearly dominates the carbonate assemblage (Stehli and Hower 1961; Garish and Friedman 1969). In the English Channel, however, aragonite can reach concentrations of 50% of the total sediment. Low-magnesium calcite can rise to 60% and high-magnesium calcite 25% (Sturrock 1981). Although such comparisons are complicated by the relative

carbonate production and non-carbonate supply of each environment they further illustrate the large ranges of carbonate components possible in temperate climates.

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