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AN ARAGONITE-CEMENTED VOLCANIC BEACH ROCK NEAR BILBAO, SPAIN

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SUMMARY

An unusual beach rock occurs near Bilbao. The beach is aragonite-cemented and contains melilites/volcanic glass fragments for which there is no apparent source. Man-made bricks and fresh bone fragments suggest that the beach is very young.

INTRODUCTION

A recent cemented beach rock occurs near Punta de la Galea a few kilometers from Bilbao (fig. 1). Further to the east the bays do not show such beach rock and consist of modern beach sand, while immediately to the west occurs the mouth of the R. Nervion. This beach rock is rather unusual because it consists dominantly of volcanic rock fragments plus a few man-made bricks and mammallian bones. In addition, the cementing mineral is dominantly aragonite.

NATURE OF THE BEACH

The outcrops of the deposit occur in one small bay (see fig. 1 for location) evidence of the deposit being several volcanic rock pebbles on otherwise normal sand beaches. The length of the continuous outcrop is about 700 m, with a maximum width form the Eocene flysch cliff line to low tide of 200 m. Its extension seawards is not known.

Generally, the cemented beach overlies a truncated flysch surface. At present, erosion of the deposit is taking place. During storm tides, tabular fragments up to 2 m in diameter have been deposited on the strand line. The beach dips gently (about 3-5°) away from these fragments towards the sea, the strike paralleling the coast line.

Exposures show the beach deposits to vary from coarse conglomeratic layers (plate 1) to coarse grits and sandstones with a crude bedding; all are extremely hard and strongly cemented.

PETROGRAPHY

The beach deposit consists dominantly of grains of an isotropic, colourless, pink to brown or grey vesicular volcanic glass (plate 2). Also present are lavas in which phenocrysts are recognisable. Such lavas include melilites, rarer welded tuffs, reworked tuffs, spinellite and meta-basalts. In some of the glasses incipient crystalloids are visible, and occasionally melilite crystals. Typically, the latter can be altered to a fibrous structure, which is probably cebollite. Similar alteration products of melilite have been described by K r a n c k (1928) and L a r s e n (1942). In some cases almost complete replacement has taken place.

Other grains consisted of broken oyster shells, brick fragments, calcareous siltstone, quartzites, gneissic fragments, perthitic feldspars, and mammalian bone fragments. All of these tend to be rather rare compared with the volcanic fragments.

The melilite-bearing lavas indicate a rather unusual magma type, which may have developed by crystallisation from forsterite-åkermanite or diopside-nepheline mixtures (B o w e n, 1928, 1945). There is also the possibility that limestone syntexis has taken place within a basalt magma, as described from Scawt Hill (T i l l e y, 1948).

Melilite bearing lavas are often associated with alkaline igneous activity in rift areas, such as Katunga Volcano, Africa (H o l m e s, 1937) and the Rhinegraben (W i m m e n a u e r, 1967). However, as the age of opening of the Bay of Biscay is thought to be Upper Mesozoic (C h o u k r o u n e, L e P i c h o n, S e g u r e t & S i b n e t, 1973) or Late Triassic to Late Cretaceous (P i t m a n & T a l w a n i, 1972), it cannot be directly related to this crustal rifting because the volcanics are probably of Late Tertiary or Quaternary derivation (see below, discussion Holocene age of beach).

The cement was examined under the microscope and with the scanning election microscope. It consists of aciform aragonite (plate 3) which has developed radially on the surfaces of the clastic grains, and at grain contacts has acted as a cementing agent. Diffuse haematite cement forms local coatings that appear to relate directly to alteration of specific grains. Patches of amorphous carbonate and indefinable clay occur as some interstitial patches.

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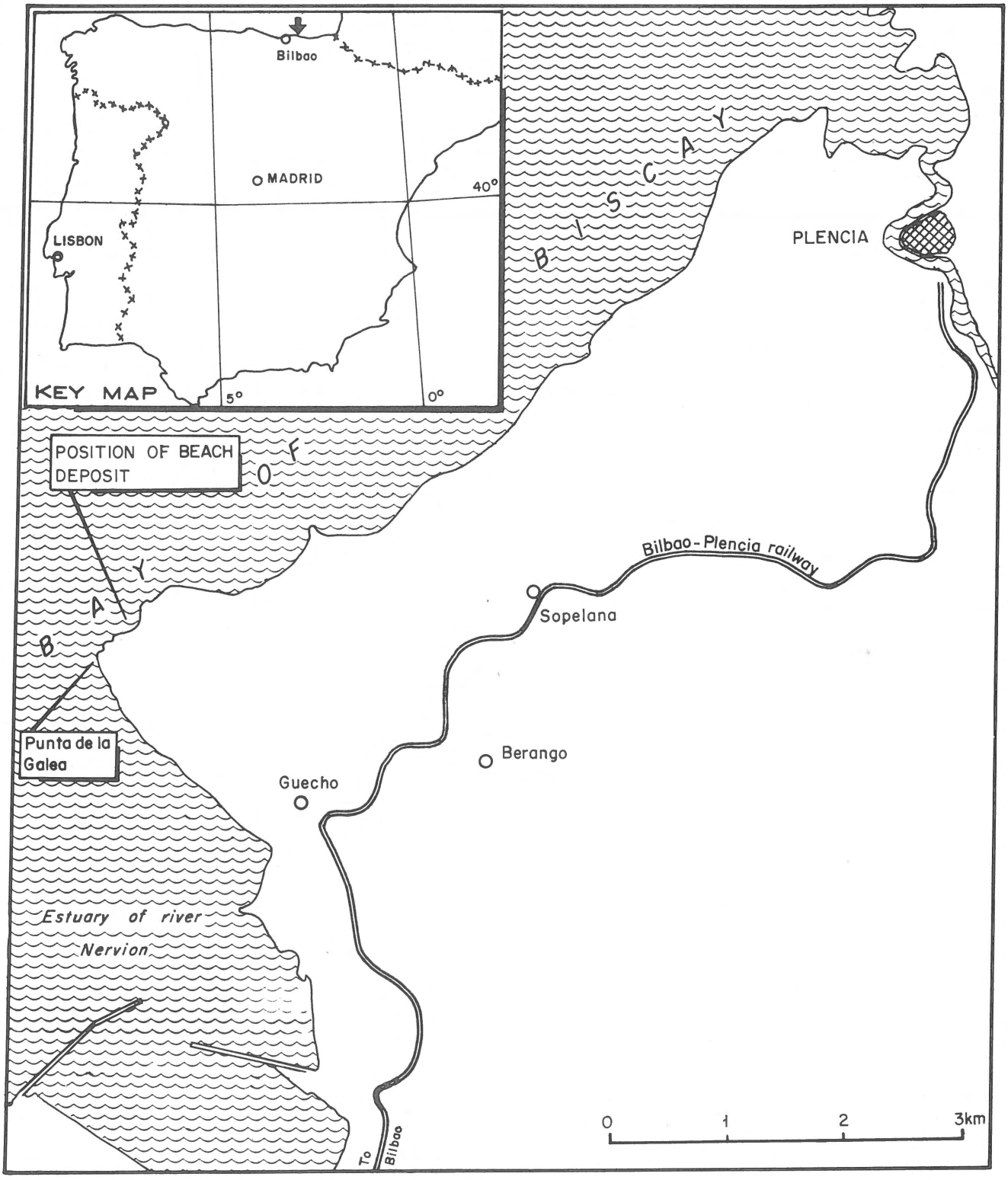

LOCATION OF CEMENTED BEACH DEPOSIT

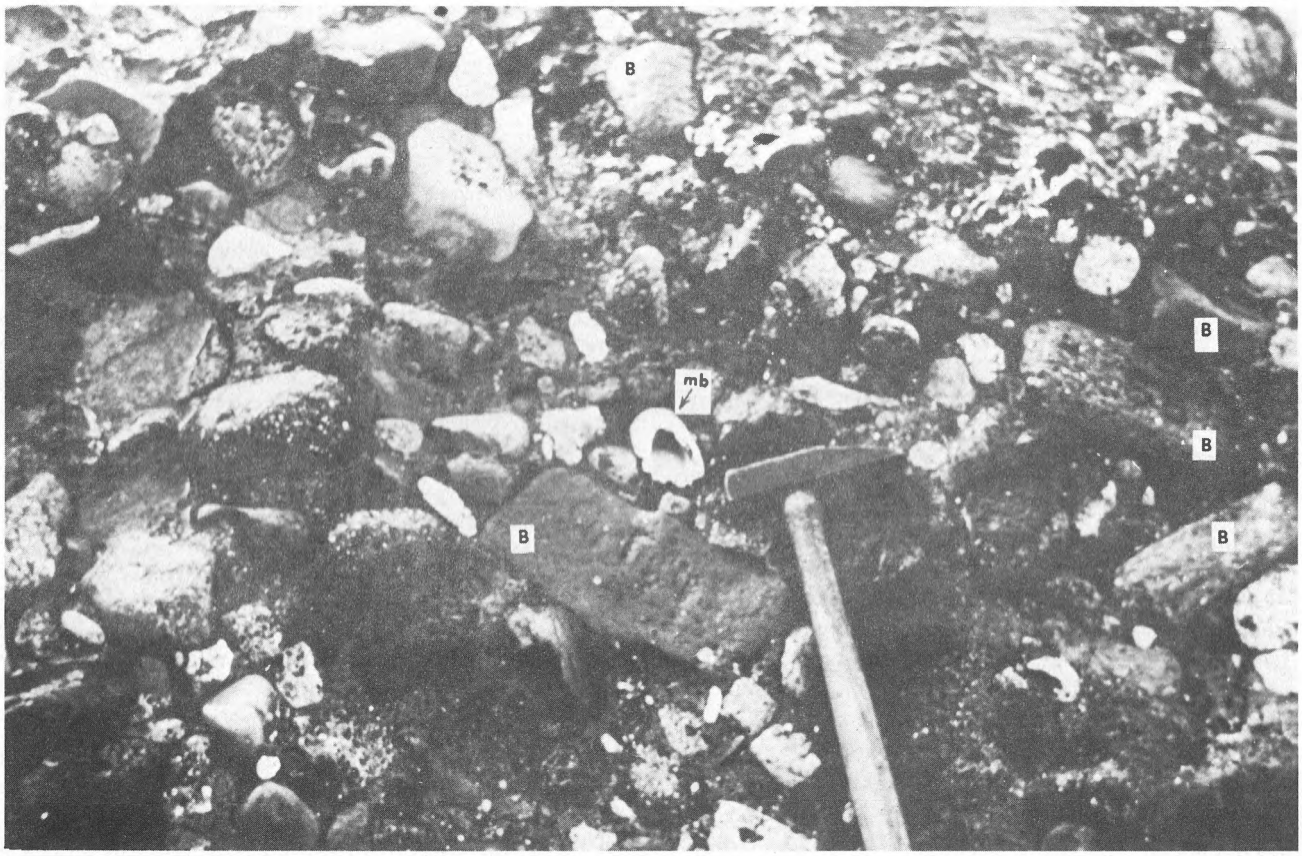

Plate 1
Coarse conglomerate layers within the beach rock consisting of mainly volcanic fragments. Also present are brick fragments (B) and a fresh mammallian bone (mb).

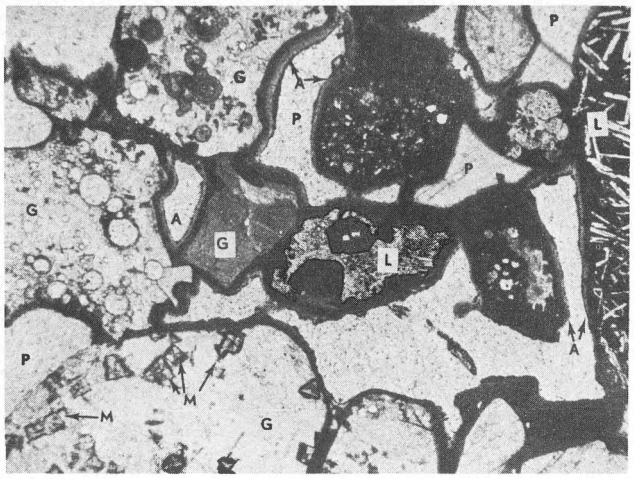

Plate 2
Vesicular volcanic glass (G) and lava fragments (L) are rimmed by an aragonite cement (A). Melilite phenocrysts occur in one fragment (M). Pore space (P) is considerable. (11,5 x)

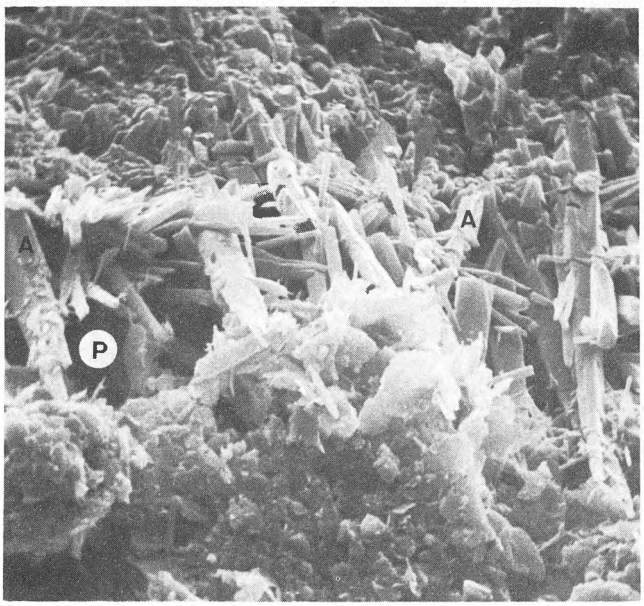

Plate 3
Aciform aragonite cement (A) forming a coating to the grains has partially filled pore space (P). (scanning electron photograph 1800x).

Several theories of beach-rock formation have been reviewed (S c h o l t e n, 1971) with regard to the source of the $CaCO_3$ cement. In this case it seems likely that the CO_3^{2-} was supplied by leaching of the Eocene cliff formations by fresh water, which then precipitated as aragonite after interaction with sea water. The Ca^{2+}ion was probably supplied in part by sea water, but could also have been supplied by leaching of the lavas.

The beach must be a Holocene feature, as in indicated by the fresh mammallian bone fragments and pieces of brick.

SOURCE

The source of these volcanics is not known. Three possibilities may be considered.

Ship's ballast may be a source but it seems unlikely that such unusual volcanic types would be used so that this is discounted.

A second possibility may be through derivation or erosion of autochthonous rocks. As the immediate cliffs consist of Eocene flysch long shore drift would be required to explain their deposition at Punta de la Galea. However, even if such an explanation could be invoked, there is a great problem in pinpointing such rocks in situ for derivation.

Finally, it is possible that the deposit is a man-made rubbish dump which has since been levelled and cemented. This then leaves open the origin of the volcanics.

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Since going to press J. Garcia Mondejar and M.A. Lamolda (personal communication) of Bilbao University have discovered that periodically bricks, ashes and other rubbish from Bilbao brick ovens are carried out to sea in special barges. The material is then dumped. It is the probable source of much of the beach rock detritals. In time it is washed up at Punta de la Galea and rapidly cemented in the intertidal zone.