

(b) Calculate the molecular proportions to two places of decimals, by reducing the sum of the molecular quotients to 100. It is sometimes stated that this can be done by slide rule, though to get sufficient accuracy for the silica, and sometimes for the other constituents, a cylindrical rule is necessary.

(c) Combine these molecular proportions in various ways to give the parameters of the rock in the two systems.

(d) Re-calculate the sum of these parameters to 100 (20 or 30 in Osann's method) to one decimal place. This can be performed by slide-rule.

The point is that operation *b* is unnecessary, and that time can be saved and accuracy increased by combining the molecular quotients in operation *c* to give the parameters. The whole operation thus involves only one reduction of a set of three or four figures to a summation of 100, with a required accuracy of 0.1, and avoids the previous reduction of a set of some ten figures to a summation of 100 with a required accuracy of 0.01.

Operation *b* is not included in descriptions of the Becke and Niggli methods.

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16th February, 1932.

THE CLAY PEBBLE BED OF ANCON, ECUADOR.

SIR,—We welcome Mr. Baldry's letter regarding the Clay Pebble Bed of Ancon, which appears in the January issue of the *GEOLOGICAL MAGAZINE*, and while a full discussion must await the publication of his paper, we desire to make a few preliminary remarks.

In the course of a recent brief visit to Peru, one of us had the opportunity of seeing some of the evidence which Mr. Baldry had accumulated in support of his theory, and was very much impressed by it. We believe that the conception of slip planes, presumably implying a state of tension, may be useful in helping to elucidate to a certain extent the geological structure of this part of the South American continent, though we should like to point out that the area covered by the theory is likely to extend much further north than the Santa Elena Peninsula and probably includes a very considerable region of coastal Ecuador. There is a significant difference, however, viz., that the principal zone of disturbance in the Peninsula itself, as well as in the area north at least as far as Manta, is intimately associated with dolerite dykes, and we are anxious to know what part, if any, these intrusions play in Mr. Baldry's theory.¹

¹ George Sheppard, "The Igneous Rocks of South-west Ecuador," *Jour. Geol.*, xxxviii, 1930.

With regard to the origin of the Clay Pebble Bed, we understand that Mr. Baldry considers it as a consequence of these movements, that is, a crush-breccia formed by the riding of one enormous block of sediments over another, the direction of movement of one block relative to the other being immaterial. We freely admit the existence of crush-breccias in the Santa Elena district, but we differentiate between them and the Clay Pebble Bed, a thing which Mr. Busk does not appear to us to do.¹

While, as Mr. Baldry says, the development of Clay Pebble at Ancon, Ecuador, is the best example to be studied, we also admit the existence of true Clay Pebble in north-west Peru.

We maintain, however, our original view that this material is a sediment, and we venture to suggest that owing to its soft and plastic nature, it has acted as a "slipper", and has readily become involved in horizontal movements, even determining at times the horizon at which they have occurred. An analogy is given by the way in which the Gault behaves in relation to the superficial landslides of the south of England.

In support of our opinion, we wish to offer two new pieces of evidence:—

(a) Near Manta, about ninety miles north of Santa Elena, we recently discovered an undoubtedly sedimentary conglomerate, from 15 to 20 feet in thickness, in which the constituent boulders measure 3 feet or more in diameter, and occurs intercalated between normal sandstones and shales. The whole section here dips at about 15°, this being the only evidence of tectonic movement. Most of the boulders consist of igneous rock though, in addition, blocks of sandstone and shale are present.

The most striking feature of the conglomerate, however, is the matrix, as it consists of Clay Pebble which is indistinguishable from the type found at Ancon. Apart from the fact that a clay matrix to a conglomerate is unusual, the presence of normal Tertiary strata both above and below suggests that the conglomerate is merely an exceptional phase in the sedimentation. It is impossible to estimate either the lateral or the inland extension of the section, but it can be certainly assumed that the conglomerate is more in the nature of a lens than a persistent horizon.

The lithological constitution of the boulders and the composition and habit of the clay matrix make it highly probably that during the normal sedimentation of the Tertiaries in this region the sequence was abruptly interrupted by the invasion of a mud flow with its attendant suite of incorporated rocks.

A similar formation to the above was described in the *GEOLOGICAL MAGAZINE* for August, 1925, before the writer had had the opportunity of examining the true Clay Pebble Bed or the region farther south.

(b) A large rolled mass, or boulder, of Clay Pebble measuring

¹ H. G. Busk, *GEOL. MAG.*, LXVIII, 1931, 240.

approximately 2 feet by 1 foot 6 inches, together with a shale boulder of similar size, is incorporated in the Socorro Series of shales and sandstones of Upper Eocene age, immediately overlying the Clay Pebble Bed of Ancon. The inference is that the Clay Pebble Bed was in existence and subject to denudation when the Socorro Series was deposited, while the evidence goes to show that the tectonic disturbances in the region did not begin until after the Oligocene rocks had been deposited.

A rolled mass of Clay Pebble has been also recorded in the Oligocene sandstones of the neighbourhood.

We await with interest the full results of Mr. Baldry's researches, and we congratulate him on the publication of the first record of the Clay Pebble in north-west Peru.

GEORGE SHEPPARD.
G. H. S. BUSHNELL.

ANCON,
ECUADOR.
10th February, 1932.

THE PLEISTOCENE SUCCESSION IN ENGLAND.

SIR,—We have read Dr. Sandford's paper on "The Pleistocene Succession in England" with very great interest, and we wish to attempt a small constructive contribution to the synthesis therein suggested. One of the chief gaps in the evidence seems to us to concern the great mass of drift deposits in the northern part of the London Basin, stretching from Goring Gap past Henley to the Vale of St. Albans and Essex. Few writers on Pleistocene chronology make any reference to this area, for little has been published about it, and palaeontological evidence is scanty. There is, however, a large body of explicit physical or morphological evidence which tells a story not widely at variance with that outlined by Dr. Sandford.

In the first place we may note that the gravels bordering the Thames between Goring Gap and the Colne Valley form a series of terraces ranging from 300 feet to 50 feet above present river level. The higher terraces are often fragmentary, but there are two which appear to mark important stages in the evolution of the Thames Valley. The first, about 200 feet above river level, has been named by one of us (B. R. R.) the Binfield terrace, from its occurrence at Binfield Heath, near Reading. It appears to correspond with the Bucklebury stage in the Kennet Valley, and the "200 feet Platform" in the east of the London Basin. The gravels from which Mr. Overy obtained primitive Chellean implements form part of a second terrace about 140 feet above river level, which we have named the Winter Hill terrace, from its occurrence at Winter Hill above Bourne End. It is equivalent to the "Silchester stage" of the Kennet Valley, and is traceable as far east as Wimbledon Common. On other evidence, we may regard this terrace as contemporary with the Middle Glacial Sands and Gravels of the