continental rocks, and the difficulty increases still more when, far from the coasts, the terrigenous materials transported by icebergs and atmospheric currents are encountered.

However, what permits us to pronounce upon the relative age of these particles, derived from showers of ashes or from the alteration of rocks of recent eruptions, is their position in the deposits; they are distributed in all the pelagic deposits in process of formation. They are found in the superficial muddy layers forming the bottom of the sea at points where mechanical actions could not have torn them from the subsoil and transported them to a distance; indeed, we must regard the bottom of the ocean as everywhere covered by deposits made up of free particles which have accumulated during long ages upon the solid rocks constituting the true subsoil. It must then be admitted that the muddy layer into which the dredge or trawl can sink only a few feet from the surface is of recent age, or at the most Tertiary in certain points of the Pacific, where numerous vertebrate remains were procured. We have still another proof of the recent age of these volcanic ashes in the fact that the vitreous particles have in many instances still preserved their original fresh characters, whereas in the older geological formations similar particles have undergone profound alteration. The same argument holds good for the isolated mineral particles associated with the vitreous splinters. Although alteration has commenced in an appreciable manner in many of these minerals and fragments, it may be said that in the majority of cases it is not far advanced.

In the year 1883 we published a memoir[1] on the characters of volcanic ashes and the products of the disintegration of pumice and lapilli found in marine deposits. These characters have been in part given under the heading of pumice. In addition to the characters due to form there pointed out, the abundance of embryonic crystals and of skeletons of crystals may be regarded as likewise characteristic of these particles. The presence of crystals arrested in their development may easily be accounted for if we remember that the vitreous material which encloses them has been suddenly cooled, and that molecular changes have consequently been suddenly interrupted.

The mineral particles in a deep-sea deposit having been derived from a great variety of sources, it is as a general rule impossible to say which of the volcanic particles have been derived from the basic, neutral, or acid series of rocks, and owing to this mixture chemical analysis is not available as a means of interpretation. Sometimes, however, it is possible to state with considerable certainty that the volcanic particles have been derived from a shower of ashes from a single eruption, as, for instance, in the case represented in Pl. IV. fig. 3 from the South Pacific, Station 281, 2385 fathoms. Here the coarser particles have fallen upon a Red Clay, the point of junction being represented by the dark line in the centre of the section, finer and finer particles lying in layers above these just as they have fallen more slowly through the water. In Pl. XXI. fig. 2 the larger mineral particles of this volcanic ash are shown at the line of junction

[1] *Proc. Roy. Soc. Edin.*, vol. xii. pp. 474 *et seq.*