However, if air bubble elimination from large masses of ice after closing of communication between pores should exist (reports of Arctic and Antarctic expeditions on clear ice in "cold" glaciers are inconclusive), then the mechanism of elimination would have to be considered one of the major problems of glacier mechanics. Even elimination from narrow bands remains to be explained.

The validity of the hypothesis suggested in this paper depends on the validity of the premises. It can reasonably be argued that we do not know how deformation of the crystals by basal translation will affect air bubble volume and pressure, and that we may not therefore assume that bubble pressure will lag behind hydrostatic pressure as the ice sinks, and will remain higher than hydrostatic pressure as the ice rises.

The grain size of the Malaspina bubbly ice is of the order of magnitude of inches. The structure of this ice, which shows marked departure from random orientation, will be described elsewhere.

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UNGLACIATED ENCLAVES IN GLACIATED REGIONS

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FROM the time when the hypothesis that regarded the "drifts" as the products of a glacial submergence was abandoned in favour of the view that attributed them to land ice, it has been recognized that some parts of Britain within the general area which was overrun by ice may never have been so invaded. Yet there has been no unanimity about the number or extent of such unglaciated enclaves. James Geikie [1] in 1894 represented practically the southern half of the Pennines as unglaciated, though he believed that ice filled the vales of York and Trent; Jukes-Browne [2] in 1922 reversed the representation indicating no ice in the lowland south of the Escrick moraine but covering the adjoining upland with a field of Pennine ice. Such contradictory views clearly imply a rather fundamental lack of agreement as to the criteria that may be held to demonstrate the existence of unglaciated areas, and it therefore seems desirable to draw attention to the present position of this still very open problem.

The criteria that may be used in this matter are of three kinds:

First, there is the negative evidence, namely the absence from the area in question of moraines, boulder clay and erratic blocks. Though negative, this evidence may on occasion be conclusive, as when an upland rises above the altitudinal limit of the drifts of a lowland ice-mass. Farrington [3] has discussed just such cases in the south of Ireland.

Second, there is the evidence—positive as far as it goes, but limited in its direct application to certain phases of the glaciation—provided by marginal drainage and overflow channels. As is well known such evidence shows that the moors of north-east Yorkshire were ice-free during the glacial episode that was responsible for the "newer drifts" of England and for the terminal moraines at Escrick and York. But this evidence cannot inform us what was happening in north-east Yorkshire during the periods of the "older drifts."

Third, there is the direct evidence provided by the characters of the supposedly unglaciated areas themselves—their "unglaciated" landforms and their surviving pre-glacial features. A generation of Norwegian workers has given attention to this aspect of the problem. These investigators are satisfied that certain plateau surfaces in Lofoten and Finnmark (of varying altitude but of smooth, past-mature aspect, bitten into more or less deeply by the forms of local glaciation, and covered up by a mantle of deeply weathered rock *in situ*) have survived virtually unmodified since pre-glacial times, uninvaded by the general Scandinavian ice. The writer of this note has recently summarized these Norwegian observations,[4] and put forward the suggestion that among the features to be regarded as pre-glacial survivals are the *tors* that characterize alike unglaciated Dartmoor, the South-Pennine driftless enclave, some of the Norwegian areas described by Nordhagan and parts of north-east Scotland not previously thought of in this context. Tors are particularly striking on the high summits of the Cairngorm mountains on a past-mature surface which is known to be long pre-glacial.[5] This region also yields numerous instances at lower levels of the survival of the pre-glacial mantle of deeply-rotted rock *in situ*. It is not suggested that all such instances of the survival of deep weathering imply that ice never visited the area. The cases of granite and gneiss weathered to depths of ten and twenty feet and overlain by boulder clay or moraine, revealed by recent excavations in the city of Aberdeen and recorded by Professor Phemister and Dr. Scott Simpson,[6] are a valuable corrective to such a notion. But the evidence points strongly to the possibility that within north-east Scotland some upland areas characterized by tors and other features surviving from pre-glacial times have never been invaded by ice of the general glaciations.

It is in fact possible that the carapace of ice which enveloped so much of Britain in Quaternary times was less continuous than the generalized maps of our text-books have encouraged us to think. The diminution of precipitation from west to east means a rise of the firn line in the same direction and it is eminently possible that in the southern Pennines, north-east Yorkshire and parts of Banffshire and Aberdeenshire, the elevation of the firn line lay throughout the Ice Age above that of the local hilltops, though ice of more westerly origin flooded the nearby lowlands. Even in the west, as Eilif Dahl[7] has pointed out, nunataks may exist where high mountains rise near the deep ocean. The writer believes that the field evidence is sufficient to demonstrate that Ben Loyal (2504 feet, 763 m.) in Sutherlandshire was a nunatak of this kind, and suspects that the mountains of Harris, which he has not had the opportunity of examining but which were thought by James Geikie[8] to have been the only Scottish summits to have projected above his all-enveloping "mer-de-glace," may prove to be an even better case.

The field is fertile and awaits more workers to till it.

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