

as one possibility, a Triassic age for the salt of Jebel Usdum at the south-west corner of the Dead Sea, basing my idea on a study of the palaeogeography of the region which I illustrated by a map showing shore-lines.

The area at the north-east corner of the Dead Sea is of exceptional geological interest from many points of view and deserves much more detailed study than has been given to it hitherto. I hope that M. Avnimelech may be stimulated to undertake it himself. In the interests of accuracy of record I should like to point out that the Yabbok Valley is incorrectly marked on his sketch map as the "Yarmuk R." I can confirm his statement that the fossils described by L. R. Cox in 1925 were from the Yabbok Valley but close to the point of its debouchment into the Jordan Valley. The outcrop of Jurassic extends for some distance south of the Yabbok along the flank of the Jordan Valley, that is, in the direction of the new locality now recorded.

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#### AN INDICATOR OF WATERFLOW IN CAVES

SIRS,—The following abstract of a larger paper which I am preparing on the subject of those curious interconnected hollows seen on the walls, roofs, and floors of many caves may be of interest to speleologists.

The pattern often referred to as "honeycomb", "oyster-shell," etc., is termed by some U.S.A. geologists, "flutes."<sup>1</sup> It is also observed in surface streams and rivers, but in the absence of sub-aerial weathering, it is best developed in caverns. I have proposed the term "pocket" to describe these forms and "pocketing" the process, as the American term "flute" and "fluting" is apt to be confused with long groovings (e.g. near waterfalls).

Pocketing is the result of directional waterflow of high velocity causing a complex of vortices under certain conditions. These vortices, helped by the abrasional power of the stream load and in the case of limestone also by solution, tend to scour out asymmetrical pockets with a steep side invariably upstream and a broader surface (usually ending in the apex of a triangle) downstream. Variations in stream velocity and redistribution of the vortices cause overlapping of pockets, etc.

Tubular-sectioned cave passages, pocketed on walls, ceiling and floor, postulate a completely water-filled passage, often under hydrostatic pressure flow. Thus pockets are known to indicate an *upgrade* flow in some caves.

The chief interest of pocketing to the speleologist is that it provides a means of plotting the direction of waterflow in dry stream-deserted passages and caverns; that is if pocketing is present and not obscured by dripstone, etc.

The following rules will help to establish the direction of waterflow which formed the pockets:—

<sup>1</sup> Bretz, J. H., "Vadose and Phreatic Features of Limestone Caverns," *Journ. Geol.*, 1 (1942), 675–811.

1. If, standing close to a pocketed wall and looking along the face, a series of roughly triangular "peaks" is seen, you are looking *downstream*.

2. If the view is a series of wavy ridges with almost complete absence of points, you are looking *upstream*.

3. A pocketed surface looked at in plan with a light held close to the surface and pointing downstream, will show a series of bright faces, outlined by dark ridges. The steep upstream "scarps" of the pockets are in shadow.

4. The same surface looked at with the light in the opposite direction gives a dark pattern picked out by the now brightly illuminated upstream scarp edges of the pockets.

Another helpful point, when in doubt, is provided by cross-sections of a number of individual pockets. The different aspects of pocketing under Nos. 3 and 4 can be successfully photographed. A curious optical illusion is often seen in plan photographs of pocketing; instead of pockets one is inclined to see convex forms.

I have tried out directional plotting in a number of active and non-active cave systems in Ireland.

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## REVIEWS

MAPA GEOLOGICO PRELIMINAR GENERALIZADO DEL PERU. Scale 1 : 8,500,000, with explanatory memoir. By J. A. BROGGI. pp. 14, with folding coloured map. Instituto Geologico del Peru. Lima, 1945.

MAPA GEOLOGICO GENERALIZADO DE BOLIVIA, Y MEMORIA EXPLICATIVA. By V. OPPENHEIM. *Bol. Soc. Geol. del Peru*, xvii, pp. 22, with coloured map. Lima, 1944.

Up to the present time there has been no geological map of the whole of Peru. The present publication, considering the small scale (the map measures 10 by 7 inches) is naturally very generalized, as the title implies. The formations coloured are Precambrian, Lower and Upper Palaeozoic, Lower and Upper Mesozoic, Kainozoic, Pre-Tertiary and Tertiary Igneous. The Republic has always been regarded as including three zones: the Coastal Region, the Sierra, and the Selva, the last named, entirely Tertiary, being in fact the headwater region of the Amazon. The Pre-Tertiary igneous rocks are mostly in the coastal region, while the rest form the Andes, with still active volcanoes. A list is given of publications on the geology of the country, other than those included in the *Bulletins of the local Geological Society*, which have appeared since the publication of Steinmann's great work *Geologia del Peru* in 1929.

Although the scale of the map of Bolivia is about four times as large