According to Washburn (1956), secondary sorted circles within large primary ones have been described by Poser, but such secondary *polygon* development is not mentioned in Washburn's review.

If any readers are acquainted with further records of such patterned ground or have suggestions as to its origin, I should be pleased to hear of them.

In addition, a simple laboratory experiment was devised to demonstrate stone stripe formation. This illustrated that forces analogous to alternating contraction and expansion could result in stripes.

A large polythene bag (2 ft 6 in by 4 ft; 0.76 by 1.2 m) was anchored at the base. It was filled to a depth of about 1 ft 9 in (0.53 m) with soil containing a number of small flat stones up to 0.5 in (1.25 cm) across. The neck was gently pulled up about 6 in (15 cm) and allowed to descend repeatedly (Fig. 3a and b).

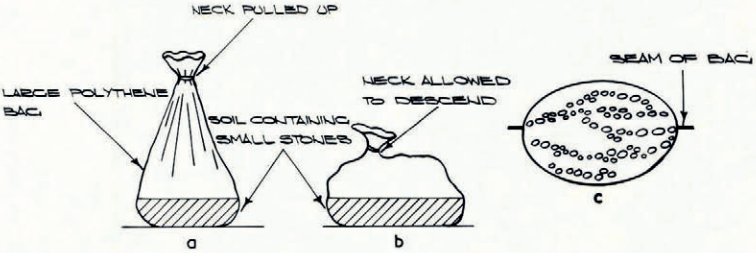

Fig. 3. Experiment devised to produce stone patterns in a polythene bag (a, b). Surface view of stone patterns after about 50 oscillations (c)

This compressed and relaxed the soil round the edges, simulating contraction and expansion. Since the bag was a simple one consisting of two polythene sheets sealed together, the forces were only operative perpendicular to the sides of the bag. After about 20 elevations, lines of stones appeared, trending parallel to the sides of the bag (Fig. 3c), and perpendicular to the applied force. A round-bottomed bag would yield polygons.

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1 June 1967

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REFERENCE

Washburn, A. L. 1956. Classification of patterned ground and review of suggested origins. *Bulletin of the Geological Society of America*, Vol. 67, No. 7, p. 823–65.

SIR,

Errors in the determination of ablation using stakes

It seems that most mass balance determinations with a net of ablation stakes have been made without taking into account the fact that, when the lines of flow are not parallel, the emergence $-e$ (variation of the length l of the stake immersed in ice) of the stakes is not equal to the ablation $-b$. This is perhaps one of the causes of the curious undulations shown by curves of ablation versus altitude.

Ice being incompressible $\partial w/\partial z = -(\partial u/\partial x + \partial v/\partial y)$ (evident notation; Oz vertical, positive downwards).

For a stationary glacier w on the surface is $-b$; at the lower end of a stake of length l, w is $-b+l\,\partial w/\partial z$.

When short stakes are used it is generally their feet which are linked to the ice (in temperate glaciers, where holes are full of water and do not close, an anchorage at the foot is necessary when wooden stakes are used). Thus the emergence of a stake will be lower than the ablation in compressive flow ($\partial u/\partial x < 0$) and higher in extensive flow.

This effect is generally a small one, but it is not negligible—for instance if $l = 2$ m, $\partial u/\partial x = -0.1$ year^{-1}, and $\partial v/\partial y = 0$, it implies that $-b = -e+0.2$ m). Its correction is absolutely necessary near ice falls, as $\partial u/\partial x$ rises to 0.3 to 1 year^{-1}. To calculate the correction it is necessary to remember that strain-rate is a continuous process and ablation is an intermittent one, and that while it is occurring strain-rate acts on a variable length l.

It is usually convenient to set systematically two stakes (about 10 m apart) along the same line of flow to evaluate $\partial u/\partial x$ (it is almost always possible to estimate $\partial v/\partial y$ on a small-scale map by observations of divergence or convergence of moraines or active glacier edges).

When articulated stakes (rods with an anchoring system at the foot of each, joined together with little chains) are used, it is necessary to know whether lower rods have or have not pulled or pushed the upper rod.

In regions of extending flow the whole stake is pushed up by the lower rod and knowledge of $\partial w/\partial z$ is sufficient, but when the flow is strongly compressive it becomes necessary:

(1) to provide a sufficient length of chain and a very good anchoring system (such as a stainless steel spring blade of sufficient length);

(2) at every survey, to note if the upper rod is well anchored, to push it down, and note its emergence before and after pushing.

In a cold glacier anchorage is very good and it is necessary to estimate carefully the minimum length of all the little chains (ablation often being small, the stakes will stay in the ice a very long time).

I would like to thank Professor Lliboutry for his good advice and criticism.

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14 April 1967

Michel Vallon

Sir, *Errors in the determination of ablation using stakes: comments on Dr. Vallon's letter*

It may just be worth adding the following remark to M. Vallon's letter. When the strain of the ice over the interval considered is large it is perhaps not immediately obvious how to calculate the correction term, because the length of stake buried in the ice, the gauge length, is changing over the interval in an irregular way, as the ablation rate changes. But, if one assumes that the vertical strain-rate $\dot{\epsilon}$ is constant, it is easy to show that

$$b = e+\bar{l}\dot{\epsilon}\Delta t,$$

where b is the true ablation, e is the length of stake exposed (the apparent ablation), Δt is the time interval, and $\bar{l}$ is the time average of the length of stake between the anchored point (which may be the bottom of the stake) and the surface. This holds for any variation in ablation rate, however irregular. $\bar{l}$ will not normally be known accurately, and must be estimated from the varying ablation rate over the interval.

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