pertinent, especially during the International Hydrological Decade with widely dispersed observers facing similar problems.

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REFERENCE

Gilbert, O., *and others*. 1969. Regime of an Afghan glacier, by O. Gilbert, D. Jamieson, H. Lister and A. Pendlington. *Journal of Glaciology*, Vol. 8, No. 52, p. 51–65.

SIR, *The stress dependence of the secondary creep rate at low stresses**

The claim has been made in the past, and more recently (for ice) by Mellor and Testa (1969[a]), that the stress dependence of the secondary creep rate (that is, the steady-state creep rate) changes at low stresses. We have pointed out before (Weertman, 1967) that experimental creep rates cited in favor of such a claim usually can be dismissed because they clearly do not correspond to true secondary creep. Our argument is the following: In order to be certain that, at a given stress, it is true secondary creep which is being measured rather than transient creep, it is necessary to obtain the creep rate over a total creep strain of at least the order of 0.1 (10%). Thus the smallest steady-state creep rate that can be measured reliably in a year-long laboratory test is about 10^{-8}/s. In Mellor and Testa's (1969[a]) work the tests used to show a different stress dependence involved creep rates in the range of 10^{-10}/s to 10^{-11}/s. These creep rates were described as secondary creep rates. (The 0°C tests (Mellor and Testa, 1969[b]) led to very much faster creep rates. The authors pointed out, however, that the 0°C tests had the complicating factor of grain growth. These particular tests need not be taken as proof of a change of stress dependence of creep rate.)

It should be emphasized that Mellor and Testa are well aware of the difficulty of obtaining a true secondary creep rate at low stresses. They point out that their conclusion about the stress dependence at low stresses is not conclusive because of this difficulty. The purpose of our letter is to point out that although Mellor and Testa used creep tests that ran for almost one year, the time duration of their tests is, nevertheless, many orders of magnitude too short to establish a true secondary creep rate at low stresses. Therefore, no conclusion at all can be made of the stress dependence of the secondary creep rate at low stresses.

An example can be cited to prove that the stress dependence of the creep rate can be quite different at very small creep strains from what it is at large creep strains. In a microcreep experiment (which repeated Chalmers' original experiment) on tin crystals Harris and others (1966) find (as did Chalmers) that the creep rate is proportional to stress. The test temperature was room temperature and the stresses ranged from about 1 to 20 bar. The total creep strain displacements were so small that an optical interferometer technique was required to measure them. Yet in this same stress range creep experiments on tin single crystals which were carried out at about 200°C and which extended to large strains led to creep rates proportional to the stress raised to about the 5th power (Weertman and Breen, 1956).

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9 May 1969

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REFERENCES

Harris, A., *and others*. 1966. Microcreep in tin crystals with 0.001% to 0.44% lead, by A. Harris, R. L. Hines and E. R. Peck. *Acta Metallurgica*, Vol. 14, No. 9, p. 1115–19.

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Mellor, M., *and* Testa, R. 1969[a]. Creep of ice under low stress. *Journal of Glaciology*, Vol. 8, No. 52, p. 147–52.
Mellor, M., *and* Testa, R. 1969[b]. Effect of temperature on the creep of ice. *Journal of Glaciology*, Vol. 8, No. 52, p. 131–45.
Weertman, J. 1967. Discussion of "The stress sensitivity of creep of lead at low stresses". *Transactions of the Metallurgical Society of AIME* (American Institute of Mining, Metallurgical and Petroleum Engineers), Vol. 239, No. 12, p. 1989.
Weertman, J., *and* Breen, J. E. 1956. Creep of tin single crystals. *Journal of Applied Physics*, Vol. 27, No. 10, p. 1189–93.

SIR, *The stress dependence of the secondary creep rate at low stresses: reply to Professor J. Weertman's letter*

Our work (Mellor and Testa, 1969) was prompted by disbelief in the claimed Newtonian behaviour of ice at deviator stresses below 1 bar; our results appear to dispose of this claim, or at least to discredit the evidence on which it is based. Our final conclusion was that classical creep tests become impractical for stresses below 0.5 bar. Thus, to the extent of our published conclusions, we seem to be in complete accord with Weertman.

We were careful to point out that the results do not establish a firm stress/strain-rate relation for the low stress range, although they do provide a better approximation to secondary creep rates than those previously available. We did mention in a footnote the similarity between our apparent stress/strain-rate relation and a corresponding one derived from glacier flow observations, which were not subject to a serious time restriction.

While conceding the inadequacy of existing data for the low stress range, I would question the implication that a simple power relation (for ice) must necessarily be maintained over an indefinite range of strain-rates. New studies on the ductile–brittle transition (as yet unpublished) show stress tending to a limiting yield stress at high strain-rates, and many earlier investigations suggest curvature of the log–log plot at low strain-rates. Furthermore, indirect evidence (such as the temperature dependence of creep) causes one to doubt whether the straining of impure polycrystalline ice at very high homologous temperatures can be controlled by a single physical process.

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REFERENCE

Mellor, M., *and* Testa, R. 1969. Creep of ice under low stress. *Journal of Glaciology*, Vol. 8, No. 52, p. 147–52.

SIR, *Use of the term "glacier cave"*

A glacier cave is defined by speleologists as a cave formed within or at the base of a glacier (Halliday, 1966). When glaciologists and others refer to such caves they often use the term "ice cave". However, in popular and scientific usage ice caves are ". . . permanent caves in rock formations, in which ice forms and remains far into the summer or throughout the year" (Henderson, 1933). This is now accepted practice in the field of speleology, and it would avoid confusion if the term ice cave were no longer used to refer to caves in glaciers or other bodies of ice.

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REFERENCES

Halliday, W. R. 1966. *Depths of the earth—caves and cavers of the United States.* New York, Harper and Row.
Henderson, J. 1933. Caverns, ice caves, sinkholes, and natural bridges, II. *University of Colorado Studies*, Vol. 20, Nos. 2–3, p. 115–18.