LETTERS TO THE EDITOR

GEOPHYSICS

Resemblance between Macro-impact with a Great Meteorite and Micro-impact with a Drop or Sphere

RECENTLY G. G. Johnson *et al.*[1] have computed and shown a height contour map (extending over a diameter of 33 miles) for the crater and surroundings of the meteoritic impact crater, Ries Kessel, in Germany (15 miles across).

I have been struck by the fact that this macro-contour map very closely resembles many of the optical interferometric microtopographical contours observed in my laboratory during experiments made in 1956 on the damage done to moving surfaces by a collision at speed either between a suspended water droplet, or when a surface at rest is struck by a small high-speed polythene sphere[2].

It will suffice to reproduce here but two multiple-beam interferograms. In one set of my experiments, a drop of water of radius 1 mm was suspended from a fine fibre and at this was fired a small cylinder, with flat polished ends, using a small air-gun and a pressure cylinder. Speeds up to 900 m.p.h. were attainable with the equipment available. Cylinders of a variety of materials were used and, after collision and recovery, the damage produced by the impact was assessed by taking multiple-beam interferograms of the region of collision, using green mercury light and standard multiple-beam interferometric techniques.

Fig. 1 shows (at 40 times in extension, but of course with the high magnification of interferometry in the up-down direction) the crater formed by impact at 750 m.p.h. between a moving 'Perspex' cylinder and a stationary water drop. If reference be made back to the macro-topographical meteoritic crater contours of Ries Kessel shown by Johnson *et al.*, it will immediately be recognized that the two impact patterns, the micro- and the macro-, strikingly resemble each other, in crater, in rim pattern, and in other features.

The micro-interferogram happens to extend to a greater distance from the impact centre than does the Ries Kessel diagram, and this leads to a possible prediction about the latter. For a notable feature in the interferogram is the fact that on the rim, and more so outside it, there exists a considerable region of microscopic 'crazing', clearly an extensive series of microcracks. Such micro-crazing is even still more marked in our second set of experiments, that is, those in which small spheres of polythene were fired at speed at stationary targets; which, of course, simulates the meteorite impact situation.

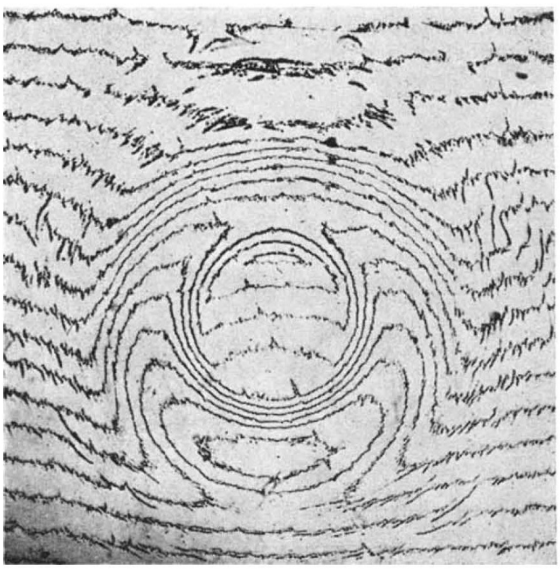

Fig. 1

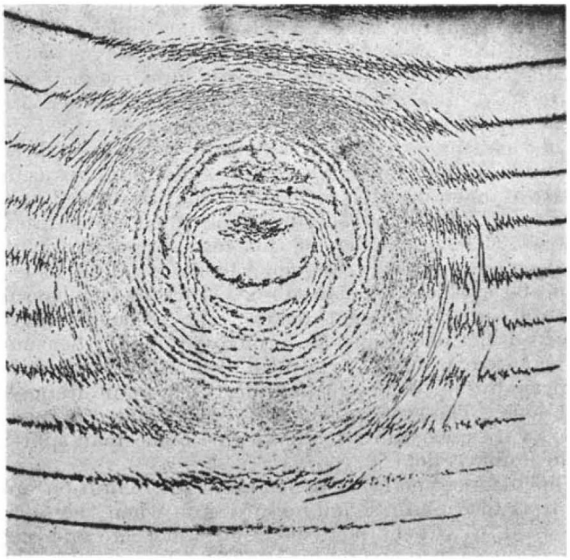

Fig. 2

Fig. 2 shows such an interferogram on 'Perspex' and the extensive crazing is notable. If, indeed, there does exist a close analogy between my micro-crater and the macro-crater of the meteoritic impact, then one can predict that outside the region of the Ries Kessel shown, one could anticipate crazing, or shearing cracks, to occur within a circle of diameter of about 60 miles or so. Indeed, there already appears some evidence of such cracks in the outer contours given by Johnson *et al.*

Some of my observations on water-drop impact have already been discussed elsewhere in connexion with the problem of rain erosion suffered by impact with rain-drops by high-speed aircraft, but it appears now that the observations may have a real bearing on problems of meteorite craters. It may, therefore, be appropriate in this connexion to direct once more attention to a crude relation I have already reported relating the volume of a micro-crater (as found interferometrically) with the velocity of impact. For different materials, and in the velocity range available to me, I find to a very rough approximation that the volume eroded obeys a power law, which ranges actually from the high value of V^8 indeed to about V^{16}, in which V is the velocity. It is this formidably high power law which explains the great multiplication of rain erosion damage as the aircraft velocity mounts up.

If a law even remotely approaching this operates in the case of meteoritic impact then it might indeed be possible to secure an approximate indication of impacting velocity from the character of the crater, namely, its volume and the range of damage.

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[1] Johnson, G. G., Vand, V., and Dachille, F., *Nature*, **201**, 592 (1964).
[2] Tolansky, S., *Surface Microtopography* (Longmans, 1960).