12:45 P. M. on March 7, 1934, in the Mangwendi Native Reserve, 40 miles east of Salisbury. A brilliant meteor (fireball) was seen, and three loud detonations followed by a rushing noise were heard. The detonations were heard over a radius of 50 miles. The natives said, "The sun came rushing from the sky and buried itself in the earth," and they called the stone "Miminimini," meaning "something to make you gape." In its fall it broke off the branches of a tree and made a hole 3 feet across and 18 inches deep in stony ground. The stone itself was broken by the fall. In addition to the main mass several small pieces were recovered, and the weight of the whole must have been about 60 pounds. But this could have been only a fraction of the original weight when the stone entered the earth's atmosphere at a height of about 100 miles. Travelling with an initial velocity of 20 to 40 miles a second, the intense heat developed by the resistance of the air melted and dissipated material from the surface, causing a rapid diminution in size of the stone and in its velocity. Fortunately, the stone was secured soon after its fall by the officers of the Geological Survey of Southern Rhodesia, and in the Survey Laboratories at Salisbury it has been submitted to a detailed and complete chemical and petrographical investigation. There it was found that it consists mainly of stony matter with small proportions of metallic nickel-iron (3.17 per cent.) and iron sulphide (trolite, 4.98 per cent.). The stony portion consists of olivine, enstatite and felspar, forming a compacted mass of minute broken fragments with curious rounded grains (chondrules). The new Rhodesian meteorite is the fifth largest stone in the collection.

DISCUSSION

THE MOTION OF GLACIERS

MANY persons who are not especially concerned with other topics in the field of glaciology are interested in the problem of the nature of glacial flow. Accordingly, it seems not inappropriate that there should be a notice in SCIENCE of a paper[1] which, if not conclusive on this question, does give the mature view of a specialist, competent in physics and mathematics, who has given a lifetime to the observational, experimental and theoretical study of glaciers, namely, H. Hess, of Nurnberg. Moreover, the paper referred to is one that will be seen in the original only by the few who pursue similar studies. Further, the representations of Hess are now very fully in accord with the views of the undersigned, published a number of years ago but not then generally accepted.

Although a variety of theories of glacial flow have been formulated, most have been rejected at once because they were completely out of harmony with well-defined characteristics of glaciers observationally determined. During the past thirty or more years the question has resolved itself into a controversial attitude between a large group which adheres to the idea that glaciers are essentially rigid crystalline masses and flow through some manner of shear motion and another smaller group that considers such motion to be of the nature of a plastic or viscous yield. The shear concept implies spasmodic motion; the single breaks perhaps very small indeed, but nevertheless intermittent. If, however, the flow is viscous there should be continuous yield.

Accordingly the adherents to the shear theory have sought to demonstrate its correctness by securing graphic records through clock-controlled mechanisms that would show irregular increases and decreases in the rate of flow at the terminal parts of glaciers. In this endeavor they have been successful, even to the degree of showing differential motion of adjacent sections of ice. It has, however, long been contended by the author of this notice that demonstrated shear motion in the surficial and terminal parts of a glacier is not to be interpreted as evidence of the true nature of the flow of the ice as a glacial mass. That contention, among other things, is now upheld also by Hess.[2]

In the papers[3] by the author of this notice it was argued on the basis of many different kinds of evidence, some observational from glaciers in Alaska, some from experimental work with ice, that a glacier consists of an outer and terminal crust of rigid ice, carried along and shoved forward by a core of interior ice flowing viscously under the pressure of the exterior shell and existing at essentially the pressure-temperature melting point of ice, a temperature which declines with depth (because of the increase of pressure) to the bottom of the glacier. The viscous flow of the interior ice results from the presence of a liquid film of salt solution surrounding and separating the glacier grains. This film acts as a lubricating medium to facilitate the movement of the grains one past the other. It has been shown mathematically that such differential movement of very slight amount between the crystals will suffice in sum to account for all ob-

[1] H. Hess, "Das Eis der Erde," Handbuch der Geophysik, Bd. VII, Lieferung 1, Berlin, 1933.

[2] *Op. cit.*, pp. 80–81, 92–93.

[3] O. D. von Engeln, "Experimental Studies and Observations on Ice Structure," *Am. Jour. Science*, 190: 449–473, 1915; R. S. Tarr and O. D. von Engeln, "Experimental Studies of Ice with Reference to Glacier Structure and Motion," *Zeitschrift f. Gletscherkunde*, Bd. IX, pp. 82–139, 1915.

served rates of glacial movement and it provides the continuous motion required for viscous flow.

Such exactly is the concept now set forth in Hess's paper. In the following quotations it is attempted to translate his German precisely as to meaning. "It has become more and more clear that the motion of glaciers is due solely to gravity and that the motion is to be considered comparable to the streaming of a very viscous fluid."—p. 79. (In all other paragraphs Hess uses plastic instead of viscous to characterize the nature of the flow.)

"Ice maintained at the pressure-temperature melting point is always a mixture of the fluid and solid phases of water."—p. 12. "Every increase in pressure brings about an increase, every decrease a reduction in the proportion of the liquid phase."—p. 12. "The melt water present will concentrate preferably (chiefly?) on the boundary faces of the crystals of which the ice is composed."—p. 12. "Salts (of various kinds) are present in small quantities and surround each crystal with a thin film of material that melts more readily (at lower temperatures) than the inner parts of the crystals."—p. 6. On pages 46 and 47 data obtained from borings are tabulated to show that between 18 m and 148 m the temperatures of the ice of the interior of the *Hintereisgletscher* are, at every depth, approximately (20 per cent. lower) at the pressure-temperature melting point, and the excess of lowering is ascribed to the existence within the glacier of pressure due to motion in addition to the vertical pressure of the overlying ice. "A glacier flowing under heavy pressure must be regarded as a water-ice mixture."—p. 59. "The melt-water content of flowing ice constitutes a kind of lubricant."—p. 12. At the sole of the glacier "the ice under heavy pressure is especially plastic because of the marked increase of the fluid phase, hence ground crevasses are rather improbable. Such crevasses are not even to be expected at the foot of an ice fall where the ice has, toward the surface, a concave curvature."—p. 58. Hess points out in parentheses that as late as 1929 he entertained the contrary view, *i.e.*, that such ground crevasses were possible. This notation is important because it indicates that Hess has only recently been fully converted to the plastic-flow theory of glacier motion.

Hess summarizes (in part) as follows: "Because uniform pressure develops a small volume of water on the boundary faces of the crystallographically, irregularly oriented structure of grains (of a glacier) and because this fluid permits the aforementioned minute and slow translatory movements of the grains the whole mass of ice is plastic. . . . This plasticity increases with pressure, hence with the increase in thickness of the glacier; on the sole of which truly immense pressures are effective in the direction of motion."—p. 82.

It will suffice for comparison to quote only one statement from the paper in the *American Journal of Science*[4] by the present author to show the close agreement with Hess's conclusions. ". . . the flow of glaciers . . . does not permit of characterization as either plastic or viscous. It is plastic flow in the sense that the ice mass as a whole is permanently deformed by the movement, but its component grains are not subject or capable of such plastic deformation except in one direction, and this appears to be a minor factor. Much more important is the movement that seems to be conditioned by the interstitial film of low freezing liquid, which may be characterized as a viscous movement."

Although Hess recognizes that the liquid film between the glacier grains is a salt solution and discusses the effect of the presence of the salts in the fluid on the growth in size of the crystals (p. 7), he misses completely the significance of the solution as a guaranty that a fluid lubricant is present throughout the interior of the glacier. This last condition was a chief point in the papers by the present author.

"An aqueous solution of sodium chloride will completely crystallize at its eutectic point $-22°$ C. . . . forming a mixture of salt and ice crystals, each distinct, in the proportions 23.5 per cent. NaCl and 76.5 per cent. H_2O. . . . As it is unlikely that so low temperatures as $-22°$ C. exist far below the surface in any glacial mass it is much more probable that liquid films of salt solution develop between the pure ice granules and that this salt solution is of a concentration, therefore, a thickness, dependent on the temperature and the size of the pure ice granules. Since . . . the temperature of the interior ice (is observed) to approach the pressure-temperature melting point it follows that the interstitial films of salt solution will be progressively thicker toward the lower end of the glacier."[5]

The above quotation, together with the one given in a preceding paragraph, are enough to permit appreciation of the correspondence of the two interpretations of glacier motion and of the special significance of the salt solution to the required lubrication for inter-grain shifts. They will also serve to make clear how different this concept is from the shear theory, in which it is postulated that glacier motion is: solid flow by idiomolecular exchange between ice crystals, solid shearing of aggregates of granules, intermittent slip along well-developed thrust planes and sliding of the whole body of ice over the rock beneath.

[4] P. 471, *op. cit.*
[5] *Am. Jour. Science, op. cit.*, pp. 464–465.

Such shear concept Hess, now, and the present author earlier, hold to be fundamentally and completely erroneous.

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ON THE GREAT ABUNDANCE OF THE BLACK WIDOW SPIDER

DURING this past summer, I have found the black widow spider (*Latrodectus mactans* Fabricius) quite common in the cities of Denver and of Boulder, and I have had reports that this species was quite abundant this year in Kansas, New Mexico and in Texas. In previous years, I have found these spiders in no small numbers under rocks and in protected sand banks in the prairies around Boulder and Fort Collins and in garages and basements in the outskirts of Denver. However, this is the first year that I have taken black widows in the center of the city of Denver, except on one instance when I captured a male in a centrally located high school on November 26, 1932.

While it is true that black widow spiders are more frequently observed this year because of wide-spread newspaper reports of their existence, I am convinced that the mild winter and very dry summer here in Colorado and elsewhere have favored their development and survival, since I find them more abundant in their natural habitat as well as in the city. Perhaps, one may account for their abundance in the city by the fact that they have come in to obtain moisture and to escape the drouth. In three blocks of the downtown district in Denver, I counted thirty-two black widow webs that were constructed, for the most part, in the corners of exposed walls of stores that were adjacent to the sidewalks. Contrary to popular opinion, I found most of the webs on the sunny side of the street.

This year I have found their webs in all sorts of situations. Some were constructed in sand banks that were exposed to the sun, others in the corners of chicken coops and rabbit pens, and still others on the undersides of plant tables in greenhouses. However, the majority of the webs were in basements and in garages. I found the most frequent prey to be grasshoppers, especially *Melanoplus bivittatus* Say. In fact, I counted the remains of eleven adults in one web that was constructed in a large trash receptacle. I have also noticed a marked decrease of other Theridiidae this year in the city. Possibly *L. mactans* is beginning to get the upper hand in the great struggle for existence.

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FRESHWATER MEDUSAE NEAR BUFFALO

FRESH-WATER Medusae were noticed for the first time in western New York on August 1, 1934. They occurred in a pond a few hundred feet from the shore of Lake Erie at Bay View, Lackawanna, a suburb of Buffalo, New York. They have been collected at intervals since from the same locality. The last date was August 28 when a few were taken all of which were of large size. About thirty, collected on August 17, were kept in an aquarium at the Buffalo Museum of Science for two weeks. At the end of this time they had all disappeared. The aquarium has been left undisturbed in the hope that eventually the hydroid form may develop.

IMOGENE C. ROBERTSON

GRANTS IN AID OF RESEARCH FOR 1935

AT the October meeting of the Executive Committee of the American Association for the Advancement of Science the customary allotment of $3,000 for the grants in aid of research was approved. All applications for consideration this year must be received by the Washington office before Thanksgiving. At the Boston meeting the recommendations of the Committee on Grants were approved. These provided for continuing the practise of previous years in giving small grants for the completion of important projects already initiated or supplying apparatus or facilities where adequate funds are not otherwise available.

The official year of the association extends from October 1 to the following September 30. All grants not utilized within the year revert to the treasury on October 1. Individual grants have regularly been limited to a sum less than $500, but the small sums have been useful in meeting emergency needs or such as are not covered by other agencies.

Applications are filed on special blanks furnished by the permanent secretary's office and considered only once annually. Applications should be supported by letters from at least two sponsors personally acquainted both with the applicant and with the project. These applications are handled by the committee of which the membership for the current year is as follows: Arthur H. Compton (1937) (for Physics), *chairman,* University of Chicago; Edward W. Berry (1936) (for Geology), Johns Hopkins University, Baltimore, Md.; William Crocker (1935) (for Botany), Boyce Thompson Institute, Yonkers, N. Y.; Philip Fox (1935) (for Astronomy), Adler Planetarium, Chicago, Ill.; Carl E. Guthe (1934) (for Anthropology), University of Michigan, Ann Arbor, Mich.; Samuel Colville Lind (1934) (for Chemistry), University of Minnesota, Minneapolis, Minn.; C. C. Little (1937) (for Zoology), Jackson Memorial Laboratory, Bar Harbor, Me.; Walter R. Miles (1936) (for Psychology), Yale University, New Haven, Conn.

The report of the committee is made annually to the council, which votes the allotments in December.