in the field of the chemical transmission of nerve impulses, for studies of the respiratory center, and for important and original discoveries in the field of anesthesiology. In 1922, with W. E. Brown, Prof. Henderson showed that ethylene is a more powerful anesthetic than nitrous oxide, and it was their work, together with that of Luckhardt and his associates in Chicago, which led to the development of ethylene as a general anesthetic agent. Investigations of many potentially valuable narcotic substances led to a study, with G. H. W. Lucas, of the pharmacology of propylene and to the discovery, while searching for possible toxic impurities in this gas, of the striking anesthetic properties of cyclopropane. The fundamental studies of this remarkable compound received prompt recognition, and cyclopropane was shortly introduced into, and widely applied in, clinical anesthesia.

He was one of Banting's closest friends and staunchest supporters during the days of the search for the antidiabetic hormone and provided Banting with a university post and laboratory facilities, in the year following the discovery of insulin by Banting and Best. He also had much to do with the effort to raise funds with which to endow the Banting Research Foundation. For 16 years he served as the secretary-treasurer of the Foundation, exercising unstintingly his keen judgment with regard to the significance of proposed research projects and the progress obtained under the support of the Foundation.

Prof. Henderson excelled in the training of graduate students, who found themselves exposed constantly to sincere interest, wide knowledge, and kindly but pungent guidance. He was particularly careful to direct the investigations of the advanced student into several relatively unrelated fields, in order to prevent a restriction of scientific experience and a narrowness of outlook that are all too often encountered in graduate training. By precept and example the student was trained honestly to persevere, to observe, and to evaluate.

Prof. Henderson was perhaps at his best in his home, where it was a real pleasure to join his charming family group. It was here particularly that one appreciated his wide cultural interests and his truly lovable nature. He was especially interested in architecture and painting. During recent summers at Georgian Bay he made many water-color sketches of wild flowers that were charming in design and color and gave him much pleasure.

His colleagues the world over mourn the passing of a distinguished investigator, a splendid teacher, and a noble man.

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Technical Papers

Formation of Hyalite and Opal

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As in the case of mother-of-pearl, the optical properties of opal reflect the mode of its formation. In this respect the existing theories of opalescence constitute, however, a mere record of contrasting possibilities. Thus, L'Abbé Haüy (*6*) considered opalescence to be due to reflection from internal fissures; Brewster (*2*) attributed the display of color to the presence of microscopic cavities or minute air bubbles; and Behrens (*1*) assigned opalescence to the reflection from the thin, curved lamellae of opal, the refractive index of which may differ by 0.1 from that of the mass. These were conceived to have been formed originally in parallel position, but have been changed, bent, and finally cracked and broken in the solidification of the ground-mass.

There is considerable evidence to support the view that acidic silicic acid gels (pH value below 7.0) constitute an intermediate stage between the basic silicic acid gel and minerals of the hydrated silica type. This evidence includes the probable restriction of the monomolecular state to soluble silicates, molecular weight determinations, conditions of transition, the reduction of pH values with progressive gelation, and the general identification of coagulation with polymerization. In this light the soft, reactive basic silicic acid gel (pH value above 8.0) may be termed the *primary* or simple polymer of silicic acid; the elastic, inert acidic gel, the *secondary* or closely-linked complex polymer; and the hard, hydrated silica in the form of non-ionized minerals, *tertiary* polymers.

Recent work (*4*) on the rhythmic structures of silica and its hydrates led to the synthesis of the clear, opalescent and opaque forms of the acidic polysilicic acid gel under conditions specific to the Liesegang phenomenon. This, together with the consequent differentiation of these varieties by the presence and state of dispersion of silica particles within the colloidal

medium, have a direct bearing upon the present problem. The synthesis of these forms was preceded by the creation within the reaction medium of a whole series of diffusion regions with conditions alternating between those favoring and those adverse to peptization. This led to a corresponding periodic succession of transitions (to the inert acidic polymer) and decompositions (to silica and water) of the reactive basic silicic acid gel. The aggregation and orientation of the highly dispersed particles of silica were greatly influenced by experimental conditions resulting in semipermeable, porous, or impervious membrane bands. Again, under specific conditions the finely divided silica was carried in the upward movement of the acidic gel (a case of thixotropy), giving rise to the opalescence or opacity effect by the orientated deposition of laminar or fibrillar silica within the micellar structure of the medium. Apart from anomalies due to disturbing factors, it would seem that the network pattern of the silica orientation throughout the Liesegang phenomenon is primarily and fundamentally determined by the prototype structure of the colloidal medium.

This link between the various forms of the secondary polymer of silicic acid extends to the genetically and structurally related dehydration product, *i.e.* the tertiary polymer. Van Bemmelen (*8*) found that the gel of silica hydrate under the microscope appeared to have a cellular structure composed of a kind of network—Wabenstruktur—formed by the two solutions, the more concentrated forming the walls of a mass of cells, which enclose the other more dilute solution. This was confirmed by Bütschli (*3*), who also observed the accentuation of the network structure on drying the gel, as well as the fact that the natural opals exhibit a very fine cellular structure requiring the very greatest magnification to be rendered visible. Hydrophane, for example, with a magnification of 2,090 diameters, shows the cellular structure and is very little different from gelatinous silica. We thus perceive that all available evidence supports the observations and theory of Behrens. However, the results of the rhythmic separation of silica and its hydrates, outlined earlier, agree to the number but not to the character of opal constituents. Thus, Behrens' opal, a composite of two forms of opalite varying in density and refractive index, should be viewed as silica lamellae orientated within the network structure of a clear hyalite medium, which itself may be regarded as the pure tertiary polymer of silicic acid.

The formation of opal by the combination of external and internal (syneresis) pressure makes L'Abbé Haüy's theory hardly admissible. Any such fissures would be adventitious and a source of weakness.

As to Brewster's cavity theory, it seems to be untenable because of the fact that the appearance and general properties of the opalescent and opaque acidic silicic acid gel, the precursor of opal, were not affected by previous boiling and cooling *in vacuo* of the water-glass and the redistillation of the hydrochloric acid. These features of acidic silicic acid gels therefore were governed by osmosis and temperature conditions rather than by the presence of dissolved air in the reagents. In this respect a close analogy may be found in the rhythmic forms, especially the opacity bands, of calcium carbonate (*5*).

The formation of milky opal, opal agates, and chalcedony obviously fall within the scope of the present conception. It may be added also, that while the reactions outlined here no doubt find their prototype in nature, natural processes are not without variants, as may be seen in the function of organic life, superheated steam, carbon dioxide, and diffusion in connection with the formation of diatomite, flint, geyserite, chert, and gelatinous silicic acid (in the Alps) (*7*).

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The Metabolism of a Very Small Mammal

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It is well known that small mammals have a higher metabolism per unit weight than large ones. Thus, basal metabolic rates in Cal./kg. day ranging from 12 for the steer to 170 for the white mouse have been observed (*1*). The latter, with an average weight of 20 grams, is the smallest adult mammal on which metabolic studies have previously been made.[1] We have now made measurements on a shrew whose weight averages less than one-fifth that of the white mouse and thus is at the lowest limit of mammalian size.

The specimen used was a rather large, anestrous, female long-tailed shrew, *Sorex cinereus cinereus* Kerr, captured on Cape Cod and weighing 3.5 grams. It was extremely active, ate large quantities of worms and insects, and in all ways seemed entirely normal

[1] This excludes the "dwarf" mouse (8 grams), an endocrinologically defective strain of white mouse. Crude measurements on "a dormouse" of 6–7 grams (*5*) and measurements at low temperatures on a bat, *Pipistrella* sp. of 4–8 grams (*4*), both hibernators, have been reported.