cavities. A few cavities have been found which were virtually filled with a loose granular mass of small perfectly clear crystals. Apophyllite often occurs associated with and partially imbedded in analcite.

Mesolite forms some of the most beautiful and distinctive specimens from the Table Mountain. It frequently occurs in extremely delicate aggregates of long slender hair-like threads. Cavities several inches in diameter have been found completely filled with a cotton-like mass of these fibers. In other specimens the mineral appears as felt-like aggregates. Sometimes gauzy membrane-like deposits occur. Rarely the mesolite forms bristle-like surfaces.

Natrolite occurs sometimes in rounded masses with a well developed radiating fibrous structure. A few large cavities have been found lined with white stubby bristle-like growths of this mineral.

The other minerals listed are either rare in occurrence or usually occur in poorly crystallized condition.

These minerals weather so easily that good specimens can be obtained only in fresh exposures as in quarries. At the present time some material of fairly good grade may still be obtained from the old tramway quarries on the south side of the mountain. The quarries on the east have not been worked for a number of years and little, if anything, can be found there. During the past year a new quarry has been opened on the northwestern edge of the mountain. So far very few specimens have been obtained from it as in general the vesicular cavities are very small, the lava apparently being closer to the point of outflow.

BENTONITE AS A ONE-DIMENSIONAL COLLOID

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Crystal grains may be conveniently classed with respect to their size into four categories, macroscopic, microscopic, colloidal and molecular. When the grains of a given substance are essentially equidimensional, they fit definitely into one or another of these size-classes; but when the habit is strongly fibrous or tabular they may fall simultaneously into two (or even three) classes.

Grains of macroscopic diameter but molecular thickness have actually been prepared by Marcelin.[1] By pressing a bit of melted selenium against a sheet of mica, allowing it to cool, and pulling it off, he obtained flakes found by optical study to be 0.7μ or small multiples of that value in thickness, this evidently representing the diameter of the mica molecule in the direction perpendicular to the cleavage. Again, on crystallizing from alcohol an organic compound with strongly tabular habit, *p*-toluidine, he got crystals 0.3μ, or small multiples, thick, also clearly a molecular dimension.

In the course of the process known by the general term devitrification there should be a good opportunity for crystals falling simultaneously into two size-classes to develop. This may cover unmixing of the constituents of a solid solution, change of a transparent glass into an opaque aggregate, or passage of a colloid[2] into a metacolloid; in all these cases particles originally of submicroscopic dimensions increase to microscopic or even coarser sizes without going into liquid solution in the process. The crystal growth is therefore hindered by the viscosity of the medium in which the molecules move, and if the habit tends to be fibrous or tabular, microscopic dimensions will be attained in one or two directions, while in the remaining directions the diameter of the crystals may still be of colloidal magnitude. If the growth stops soon enough, these size-relations may persist in the final product. The purpose of the present note is to point out that such appears to be the case in the peculiar rock known as bentonite.

Bentonite and related substances have been shown by Hewett,[3] the writer,[4] Nelson,[5] and Ross and Shannon[6] to be a product of devitrification, with partial decomposition, of glassy volcanic ash. The properties of the resulting material are in many respects those characteristic of colloidal gels—it adsorbs dyes and other materials from solutions, and, in some specimens, swells markedly and becomes plastic when wet. At the time the writer's article cited was

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[1] *Ann. phys.*, **10**, 189 (1918).

[2] The term colloid is here used in the general sense of a substance with particles of less than microscopic but more than molecular dimensions; these particles may be just as definitely crystalline in structure as a microscopic crystal.

[3] *J. Wash. Acad. Sci.*, **7**, 80 (1917).

[4] *J. Wash. Acad. Sci.*, **7**, 576 (1917).

[5] *Bull. Geol. Soc. Am.*, **33**, 605 (1922).

[6] Paper presented simultaneously with this at the annual meeting of Mineralogical Society, Ithaca, New York, December 31, 1924.

prepared, the double refraction visible under the microscope was interpreted, in accordance with the usual views at the time, as a strain phenomenon; but the subsequent work of Larsen (cf. Nelson, *loc. cit.*) indicated the presence of minute crystals of a definite mineral, then regarded as leverrierite, though shown by the subsequent studies of Ross and Shannon to be more often montmorillonite. The mystery as to how a rock apparently made up largely of a crystalline mineral could exhibit such distinctively colloidal properties has not thus far been cleared up. The one-dimensional colloid theory was mentioned by the writer in a letter to Jerome Alexander, and quoted by him in his article on bentonite[7]; it is here brought to the attention of mineralogists.

When dry bentonite is moistened with an immersion oil and examined under the microscope between crossed nicols, it shows numerous doubly refracting grains. At first sight their aspect is that of fibers, but the way they behave when the cover glass is rubbed around shows that they are really plates, viewed more or less on edge.[8] Here and there through the mount they tend to aggregate themselves, with their flat faces parallel to the slide, and their double refraction is then much weaker; they show, however, distinct biaxial interference figures, with a small axial angle, in convergent polarized light, indicating that groups of them have collected together in essentially parallel position. The simplest explanation of these peculiarities would seem to be that the crystals, of whatever mineral may be present (its chemical composition being of less significance than the fact that it possesses the strong tendency to tabular habit so characteristic of the micas) are plates of microscopic breadth but colloidal thickness.

Various kinds of colloids swell more or less in water, but bentonite sometimes expands to many times its original volume. This is evidently the result of the entrance of the water between the almost infinite number of solid sheets, the broad surfaces of which are capable of exerting capillary attraction better than ordinary (three-dimensional) colloid grains. The plasticity is no doubt connected with the sliding of these sheets over one another, lubricated by the water films. The adsorptive powers for dyes and

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[7] *Ind. Eng. Chem.*, **16**, 1140 (1924).

[8] Two-dimensional colloids, made up of fibers of microscopic length but colloidal diameter, are presumably represented among minerals in some varieties of limonite, wad, etc.

other substances may well be an expression of the colloidal thinness of the flakes, yielding relatively enormous surface area with respect to quantity of material. The reason why bentonite is better adapted than many typical colloids to technical adsorption operations such as water-softening appears to be that the relatively large breadth of the particles gives their aggregates an open texture, combined with a certain rigidity, which permits the solutions being treated to come into unusually complete contact with the adsorbing surfaces.

CLERICI SOLUTION FOR MINERAL SEPARATION BY GRAVITY

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Clerici solution, a mixture of thallium malonate, $CH_2(COOTl)_2$ and thallium formate, HCOOTl is a heavy liquid little known, but it has been prepared and used with much satisfaction in the mineralogical laboratory of Harvard University. At ordinary room temperature the concentrated solution has a density of 4.25. Clerici, in his original article[1] says that by increasing the temperature, the density of a concentrated solution at 35° is 4.4, at 50° about 4.65, and at 90°–100° pyrite floats. It is possible to dilute with water in any quantity and to reconcentrate. It is more mobile than Thoulét solution, odorless and slightly amber colored. As with most heavy solutions care must be taken that minerals such as sulfides are not altered with long standing in hot solutions but at ordinary temperatures the solution appears to be stable and chemically inert.

The solution may be prepared by neutralizing two equal parts of thallium carbonate with equivalent amounts of formic acid and malonic acid, mixing the two solutions of thallium formate and thallium malonate, filtering and evaporating until almandite floats. One hundred eleven grams of malonic acid dissolved in a little water will neutralize 500 grams of thallium carbonate, and

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[1] E. Clerici. Preparazione di liquidi per la separazione dei minerali. *Atti. R. A. Lincei, Rome,* **16,** 187-195 (1907).

Descriptions of the preparation and use of Clerici solution are to be found in P. Eskola: On the Eclogites of Norway, *Videnskap. Skrift., 1MN.Kl., Kristiania,* No. **8,** p. 6 (1921), and in F. Hörner, Beiträge Zur Kenntnis des Staurolits. Inaug. Diss. Heidelberg, **1915,** quoted in Rosenbusch-Wülfing, Mik. Physiographie **I,** p. 692 (1924).