RAPID SPECIFIC GRAVITY DETERMINATIONS WITH CLERICI'S SOLUTION

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It has long been customary in certain mineralogical laboratories to use as an aid in the identification of nonmetallic minerals a series of test tubes containing liquids of various specific gravities. L. J. Spencer[1] has recently described an apparatus used in his laboratory consisting of eight test tubes of methylene iodide with a range from 2.12 to 3.32. Clear crystal mineral fragments are used as indicators and the specific gravity of the liquid is varied by adding or evaporating benzine until it matches that of the unknown mineral. The writer, inspired by Spencer's paper, has made up a set of heavy liquids and has derived considerable satisfaction from their use for a period of a year. However, Clerici's solution (thallium formate-malonate) was substituted for methylene iodide and a somewhat different procedure followed.

A frame was constructed composed of a base 2 by 6 in. with a length of 37 inches. Centered above this, with 5½ inches open space between, is a 2 by 4 of equal length. It is held in position by uprights at the end of the frame. Twenty-eight holes with a one-inch diameter have been bored through the 2 by 4 and to a shallow depth in the base. In order to conserve space these holes are staggered. Test tubes 8 inches long and one inch in external diameter occupy the holes. About 15cc. of heavy liquid fills the lower part of each test tube. This allows about 1¼ inches of the liquid to stand in the readily visible portion of the tube immediately above the base. The liquid in the first tube (at the left end of the rack) has a specific gravity of 2.0 and the gravities in the succeeding tubes increase in steps of 0.1 up to 4.1. This leaves six holes at the right end of the frame which may be used by tubes containing reserve liquid and washing water. A picture of the frame containing the heavy liquid set is shown.

[1] Specific Gravities of Minerals, an index of some recent determinations: *Mineralogical Magazine*, Vol. **21**, No. 119, Dec. 1927, pp. 337–338.

Clerici's solution[2] has a double advantage over other heavy liquids in its complete miscibility with water and in its unusually high specific gravity. The maximum specific gravity obtainable from this solution lies between 4.2 and 4.3 at normal room temperatures. To secure liquids of lower specific gravity than the concentrated solution it is only necessary to mix with water. To increase the specific gravity of dilute Clerici solutions the steam bath is used. The test tubes in the set must be kept tightly stoppered or evaporation of the water will raise the specific gravity.

Any specific gravity at the lower end of the series may be obtained down to that of water, but the small number of minerals between 2.0 and 1.0 does not seem to justify extending the set in that direction. Nearly three-fourths of the 2,277 specific gravities listed by Spencer[3] fall between 2.0 and 4.0. In making up the liquids a Westphal balance was used and water added until the

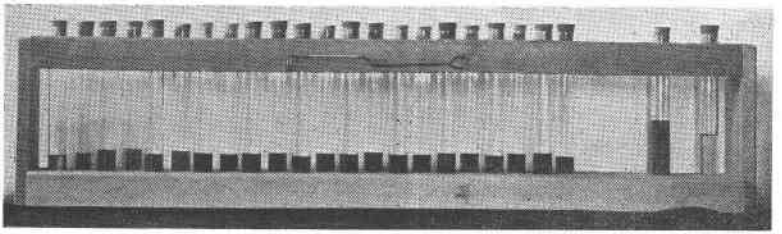

FIG. 1. Picture of specific gravity set.

specific gravity came to within less than 0.01 of the desired point. For specific gravities of 3.0 and above a special balance with an extra heavy plummet had to be secured.[4] The variation between the original specific gravity and that obtained in a recheck a year later in no test tube exceeded 0.01. A black cloth is thrown over the frame when the liquids are not being used.

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

Helen E. Vassar, Clerici solution for mineral separation by gravity: *Am. Mineral.*, **10,** 123–125 (1925).

John D. Sullivan, Heavy liquids for mineralogical analyses: *U. S. B. M., Tech. Paper* **381,** (1927).

R. G. O'Meara and J. B. Clemmer, *U. S. B. M., Serial No.* **2897** (1928).

[3] *op. cit.*

[4] Purchased through a grant from the Graduate Research Fund, University of Kansas.

For ease in immersing the minerals in the liquid a very satisfactory mineral holder was devised. The perforated bowl of a section lifter was clipped from its handle and soldered onto the ring at the bottom of a deflagration spoon from which the cup had been removed. The rigid wire handle of the deflagrating spoon was shortened to a total length of 9½ inches and looped at the top for ease in lifting. The diameter of the perforated pan is about three-quarters of an inch which allows an easy movement up and down the tube, but prevents the mineral fragment from escaping over the side between spoon and tube wall and sinking to the bottom of the test tube. The perforations are small enough so that a mineral fragment of workable size will not pass through, but large enough to permit the liquid to move readily through the pan. When not in use the mineral holder hangs on short nails on the front of the rack as shown in the photograph.

To determine the specific gravity of a mineral a clean fragment is placed on the perforated pan and lowered to the bottom of one of the test tubes and its behavior observed. If it floats the holder can be pumped up and down in the tube so that the fragment is forced below the surface of the liquid and the speed at which it returns to the surface noted. If the return is very sluggish the mineral is evidently very close in specific gravity to that of the liquid. If the mineral is heavier than the liquid the same pumping motion is used and the speed at which the mineral sinks observed. After these observations have been made the mineral is removed with the holder from the tube, the whole immersed in a test tube filled with water in order to clean off the adhering liquid, and then the mineral fragment and the moist portion of the holder dried with a towel. This is to prevent dilution of the liquid next used. The same process is repeated in other tubes until two adjacent liquids are found in one of which the mineral floats and in the other sinks. This definitely places the specific within 0.1. Then an estimate is made into the second place as judged by the degree of sluggishness with which the mineral rises in one and falls in the other. After a very small amount of experience this can easily be determined to within 0.03, which is closer than the range of most minerals. The length of time necessary to make a specific gravity determination depends, of course, upon the number of tubes that it is necessary to use. The process of immersing, washing and drying does not take over 30 seconds to the tube.

An apparatus of this sort is of very little use unless there are readily accessible tables. In the appendix of Miers's Mineralogy the minerals are placed in the order of increasing mean specific gravities. Dana's Textbook of Mineralogy contains a table of minerals commonly crystalline, in which the primary classification is by crystal system and luster (metallic or nonmetallic). Within these groups the minerals are arranged in order of specific gravities with both the minimum and maximum gravities recorded. Spencer[5] has listed in order most of the minerals for which specific gravities were published in the years 1910 to 1927. As there are about 715 mineral species included in this list and 2,277 specific gravities, it is apparent that the names of some minerals will appear at a number of places in the list. A second table gives the minerals in alphabetical order with their minimum and maximum specific gravities. For use in the laboratory in combination with the specific gravity set just described, the writer has in preparation a graphic chart which will show for any determined specific gravity all the common minerals with a range including this point.

[5] *op cit.*