rock would withdraw part of the heat from the hotter till an equality of temperature was reached. But this is not what takes place; the subsiding rock does not come into contact with strata at a higher temperature.

So far from heat being withdrawn laterally and from below, the general outflow of heat is checked in the areas where sediments are being laid down. In these areas the sphere is losing *less* heat than where the surface continues in a normal condition. A portion of the heat that would otherwise escape into space is being used up in heating the sediment.

Mr. Davison seems to have had a glimmering of this truth before completing his "Note," for the last paragraph but one is entirely opposite and contradictory to the preceding which I have quoted.

Unfortunately the effect has not been to compel him to withdraw the erroneous view, but to attempt to minimize the dynamical effect of the true one. Having dealt pretty freely with the quantitative problems in my "Origin of Mountain Ranges," I do not propose to enter upon this phase here.

To say that the sediment piled up in an earth trough "*withdraws*" heat from the underlying strata is about as correct as to maintain that covering a steam-boiler with felt withdraws heat from it. To give an illustration; if the valley of the Dead Sea were levelled up with sediment, the underlying rocks would be raised to a temperature dependent upon the thickness of the sediment and its coefficient of conductivity. The raising of the temperature of a body is not usually considered to indicate a withdrawal of its heat.

VIII.—ON THE PREPARATION OF A CHEAP HEAVY LIQUID, FOR THE SEPARATION OF MINERALS.

By W. B. D. EDWARDS, A.R.C.S.,
of the Geological Survey of India.

THE high price of all heavy liquids, and the consequent care that has to be taken in using them, the latter of course entailing great expenditure of time, were the reasons which caused me to make experiments, with regard to the manufacture of Klein's solution (borotungstate of cadmium) on a small scale. The price quoted in a well-known chemical manufacturer's price-list is 3s. 6d. per oz. My experiments have shown me that it can be made for about 7d. per oz., plus the value of the time of the maker. The process is very simple, and not much time is necessary in making it. A rough outline of the method of preparation is given by Dr. Klein in the *Comptes Rendus*, vol. xciii. August, 1881.

The apparatus required consists of two large porcelain evaporating dishes 10' diameter, two of 6', and two of 3', two glass beakers 10' deep, and two 6' deep, a glass funnel and a water bath. A fume cupboard or some arrangement for carrying off acid fumes is also necessary. The following weights given will make 160 grains of cadmium borotungstate (*i.e.* about 50 c.c.), and can be conveniently manipulated in vessels of the size given above.

Dissolve 450 grams of crystallized sodium tungstate in as little boiling water as possible. When quite dissolved, add 675 grams of boric acid in small crystals, a little at a time, and with constant stirring. This should be done in a large beaker.

When quite dissolved, the solution should be poured into a large evaporating dish and put aside in a place where it will not be disturbed or shaken. It should be covered up from dust. In about twenty-four hours, or longer, the liquid, which is of a light purple colour, should be poured off quickly into another evaporating basin from the crystals. The latter should be in the form of a hard solid deposit at the bottom of the basin. These crystals can be washed with hot water three or four times, the washings being added to the mother-liquor.

The latter will now probably be found to be in a thick pasty condition, due to the formation of small crystals. These will be found to dissolve up on heating the dish and its contents on a water bath. About half of the water can now be driven off on the water bath, care being taken not to drive off so much that a crust begins to form on the surface of the hot liquid. The solution is again set aside as before and left to cool and crystallize. The liquid is poured off into one of the smaller dishes and the crystals washed as before. This process of crystallization is gone through again until a piece of orthoclase will float in the liquid. The principal point being to always make the polyborates of soda crystallize out either as single large crystals or as a hard crystalline crust. It is impossible to separate and wash the crystals if they are very small.

Owing to the high density of the liquid, in the later stages a longer time is necessary for the sodium borates to crystallize out than at first. A piece of glass or felspar will be found to float when the liquid has been evaporated down to about 220 c.c. The next process is to heat the sodium borotungstate on the water bath to 100° C.; pour into a large beaker, and add a boiling saturated solution of barium chloride. This should be done carefully, stirring the solution while pouring the BaCl_2 in, a little at a time. The BaCl_2 solution should consist of 150 grams of crystallized BaCl_2 in about 200 c.c. of distilled water. A dense white precipitate forms on pouring the barium chloride solution into the sodium borotungstate, and this precipitate should be stirred for some minutes so as to thoroughly mix the two liquids. After a few minutes hot water should be added and the precipitate stirred up thoroughly. In a short time the supernatant liquid can be siphoned off from the precipitate. This washing process should be repeated some 10 or 15 times. The white precipitate is next transferred to a large evaporating dish, and about 300 c.c. of dilute HCl added (1 HCl to 10 H_2O); the mixture of precipitate and solution is evaporated to dryness on a water bath, about 40 c.c. of strong HCl being added towards the end.

The dried mass is then treated with about 300 c.c. of hot distilled water, the former being thoroughly broken up into fine powder with a glass rod flattened at one end.

The green sediment of tungstic hydrate is filtered off and washed, the washings being added to the solution of barium borotungstate. The liquid is evaporated down and allowed to stand. Yellow crystals are formed, and with a little care these can and should be obtained as single large crystals. The latter crystallize in two forms, one as modified tetragonal prisms with well-developed basal planes, and the other as flattened forms much resembling hexagonal forms in shape.

Nearly the whole of the barium borotungstate can be obtained, the mother-liquid being evaporated down a little more after each crop of crystals has been obtained. Towards the end of the process transparent colourless platey crystals of barium borate may separate out as well. The barium borotungstate crystals should be dissolved up in water and recrystallized once again. They should then be dissolved up in about 200 c.c. of distilled water and a solution of ClSO_4 added from a burette or a pipette, care being taken to add it very slowly, drop by drop as long as a precipitate falls, and the precipitate of BaSO_4 is then filtered off and the filtrate is evaporated down in a porcelain dish on a water bath till a piece of olivine floats on the surface. This liquid will be found to have a specific gravity of 3.46 at 60°F. , and it takes some hours before some of the salt crystallizes out and the specific gravity falls to 3.28. It might thus perhaps be used for the separation of some minerals of specific gravity greater than 3.46, though care would have to be taken not to allow crystals to form on the lighter minerals and thus sink them.

It will be found that the cost of the chemicals used will come to about three shillings, viz. :—

450 grams (nearly 1lb.)	sodium tungstate	1s.
675 „ (nearly $1\frac{1}{2}$ lb.)	boric acid	9d.
150 „ ($5\frac{1}{4}$ ounces)	barium chloride	$4\frac{1}{2}$ d.
25 „ (0.87 ounces)	cadmium sulphate ...	6d.
Pure hydrochloric acid, filter papers, etc.		$4\frac{1}{2}$ d.

The quantity of cadmium borotungstate obtained is about 160 grams, or 50 c.c. The borotungstate crystals separate out from the solution saturated when hot and are nearly colourless.

The crystals of barium borotungstate obtained earlier in the process cannot be mistaken when once seen. They are light yellow, transparent, and have a splendid lustre. The surface becomes yellow and opaque on washing with water.

The principal difficulty in the manufacture of this liquid is the care that has to be taken in crystallizing the various salts out from their solutions. There is no reason why any geologist with a little knowledge of chemical manipulation should not make his own heavy liquid, or why the manufacturer should charge such an exorbitant price as at present, as the actual time spent in making it is very small, though spread over several days.

In conclusion, I must express my obligations to Prof. Judd, F.R.S., who has afforded me great facilities in carrying out these operations.