Mineralogy. — "The use of boron trioxide in determination of minerals".
By J. Versluys.

(Communicated at the meeting of June 30, 1934).

Since the earliest days of determinative mineralogy by means of blowpipe analysis borax and salt of phosphorus have been recommended for reagents or fluxes. That borax is used and not boron trioxide 1) probably has to be attributed to the fact that the latter, when decomposing a mineral, in many cases forms compounds which are insoluble in the bead, whereas borax dissolves practically all components of the minerals. Only a few elements make the bead of borax opaque on cooling.

The ability of the borax and phosphorus salt to dissolve most substances is supposed to be a virtue of these fluxes. In 1875, however, W. A. Ross 2) recommended the use of boron trioxide even for the sake of its inability to dissolve most compounds which it forms with the components of the minerals. In his laboratory he had been using boron trioxide since 1869.

Cobalt, nickel and iron are among the metals which form insoluble compounds. This fact enables the operator to segregate them at once by dissolving the bead in hot water, after which small insoluble globules or fragments, each containing one of these metals separately, are obtained. These metals can be separated in this way. Moreover such globules of cobalt can be used for detecting the alkalies, and also for making a rough estimate of their content in the mineral. The presence of alkalies makes the cobalt spread through the bead. The bead is coloured blue as long as it is hot but when small amounts of alkalies are present it turns violet or pink after cooling. Larger amounts of alkalies make the bead blue, cold as well as hot. The boron trioxide imparts a green colour to the Bunsen flame and this green colour is only hidden when a certain amount of sodium is present. Thus the colour of the flame gives a second method of estimating the amount of sodium. Potassium in the boron trioxide bead colours the flame very faintly but when the bead is held in the outer mantle of the flame, the potassium colour is visible at the inner side of the mantle, while the flame is green at the outside. The same is true for lithium, but this alkali colours the flame strongly, and the carmine colour

1) J. Berzelius (see his book: "Von der Anwendung des Löthrohrs in der Chemie und Mineralogie", Nürnberg 1821, p. 65), and certainly Gahn before him used boron trioxide and metallic iron to detect phosphorus. Although they used boron trioxide frequently, evidently they have failed to discover the various reactions Ross performed with this flux.

is very conspicuous at the inner side of the mantle, if the amount of lithium is sufficient. The green flame of the boron trioxide, however, is not veiled by it, as by sodium.

Calcium forms a compound with the boron trioxide which is fusible, but not mixable with the molten boron trioxide, so that it segregates in the form of drops within the bead. After cooling the bead contains globules of calcium borate. These globules are not soluble in water, so that they can be liberated by dissolving the boron trioxide of the bead in hot water. Many more metals form such drops or globules in the boron trioxide bead, most of which can be distinguished from the lime globules at first glance. The lime globules have approximately the same specific gravity as the boron trioxide and they assume a spherical form. Drops of barium borate, however, have a greater specific gravity and they sink to the lowest part of the bead, so that they deviate from the spherical form.

When aluminium is dissolved in a bead containing lime globules, these give off a milky more or less cloudy substance, and gradually they are altogether decomposed, if sufficient alumina is added. The reaction offers a method for detecting alumina as well as lime. The fact should not be lost sight of that pure alumina remains undissolved in the bead, so that it does not react with the lime within a reasonable time. For this reason sulphate of aluminium is not the proper reagent but alum (Al K (SO₄)₂ 12 H₂O) can quite well be used. The potassium of the latter makes the aluminium spread through the bead and soon affect the lime globules. The whole bead then becomes milky and opaque. Should the mineral which is examined, however, spread through the bead, on account for instance of the presence of alkalies, sulphate of aluminium can be used.

When a mineral contains aluminium, it reacts with lime globules. This reaction presents a test for aluminium by the addition of lime. Either the lime (this may be CaCO₃, but it is preferable to heat it first in the flame in order to convert it to CaO and use this immediately, otherwise the bead may become cloudy) may be added to the bead before the powder of the mineral, or it may be mixed with the powder of the mineral before the latter is taken up in the bead. In case the mineral is practically insoluble in boron trioxide the present author proceeds as follows when testing for aluminium.

A small amount of carbonate of sodium (or of sodium and potassium) is fused on the platinum wire and so much of the ground mineral is added that at least all the carbonic acid is liberated. Then lime is added to the bead and this is fused until it forms a glassy mass again. The bead, thus obtained, still in liquid state, is brought into contact with a cold freshly made boron trioxide bead, which is much larger, and in such a way that part of the sodium bead adheres to the boron trioxide bead. The latter then is fused and the patch of the soda bead immediately evolves the milky substance, which is produced by the reaction of lime and alumina. This milky matter gradually affects the bead throughout. The use of excess
carbonate of sodium has to be avoided as it tends to obliterate the reaction, the bead with much alkali forming a solvent like borax. Minerals containing lime and alumina both show the reaction directly. If necessary, such minerals also are first fused with a small amount of carbonate of sodium.

Silica reacts with lime globules like alumina. It forms an opalescent substance while molten with the lime globules without decomposing them altogether. Thus the lime globules can also be used for the detection of silicon. Silicon can be distinguished from aluminium because the substances they form in the bead with lime are not quite alike. The reactions may be confused, while many minerals contain both silicon and aluminium.

Silicon, however, can be reacted for in the salt of phosphorus bead. The skeleton of silica is shown more clearly if some $P_2O_5$ is added to the bead. For this purpose, the bead is gently heated, dipped into solid $P_2O_5$, and fused at as low a temperature as possible. A mixture of phosphates with more $P_2O_5$ is then obtained. In case the mineral does not dissolve in salt of phosphorus, it may be fused with a little carbonate of sodium and then the mass is gradually converted to a salt of phosphorus bead by the addition of $P_2O_5$.

The phosphorous bead also presents a means of testing for alumina, provided alkalies are absent. When $P_2O_5$ is added to the salt of phosphorus bead, a small amount of $CaO$ imparts a pink tinge to it. Addition of 10% alumina converts this tinge to mauve. The tinges are easily observed when the bead is compared with a pure salt of phosphorus bead. In case the mineral contains alkalies, it can be broken down with carbonate of sodium and then dissolved in hydrochloric acid. The alumina can then be precipitated with ammonia and thus be freed of alkalies before being added to the bead. The pink tinge, assumed by the salt of phosphorus bead on addition of more $P_2O_5$ and a little $CaO$, can also be used to estimate the amount of alkalies in a mineral (W. A. Ross 1912, table VI, p. 109).

The use of boron trioxide and the reactions given in this article were recommended by W. A. Ross. The present author tried the methods and found them to be applicable. He then completed them by breaking down the minerals with carbonate of sodium and eventually with lime before fusing them in the bead, if necessary.

W. A. Ross gave a complete set of tests¹ for elements in the beads which, however, received no attention from other authors², although three editions of his book appeared in English and it was translated into German³. This is probably due to the fact that the way of treating the

¹) The present author was successful in reproducing most but not all reactions described by Ross.
²) Ross is quoted by J. Landauer ("Die Lötrohr-analyse", 3e Auflage, Berlin 1908, p. 12) only for his recommendation to make sublimates on an aluminium plate. In the "Chemical News" of 1877 several articles were devoted to discussions on this method.
Physiology. — The trunk myotome (Myorhizomere) in dogs, isolated by means of the method of "Remaining Motricity". By G. v. RIJNBERK.

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Since my first communication on the results of experiments carried out by means of the method of remaining motricity on the muscles of the abdominal wall, I continued the investigation and at the same time applied a technical improvement. The method, as it has been described in 1931, had the disadvantage that there was no protection against regeneration of the motor nerve fibres from the spinal cord. In order to anticipate the trophic restoration of the paralyzed muscles, obtained in this way, the experimental animals had to be sacrificed and dissection performed at the utmost 3 months after the ventral roots had been cut. Then the regeneration cannot yet do any harm. The drawback of this comparatively early examination is that the atrophy of the muscles is not yet complete by that time.

In order to avoid the risk of regeneration, I have now slightly altered the method. I isolate a spinal segment completely by extirpating three segments cranial and caudal from it, roots and all. The spinal segment involved is then left behind in an empty part of the vertebral canal, exclusively in efferent and afferent connection with the periphery. By means of this contrivance absolutely every regeneration of the cut roots is prevented. The experimental animals can now survive for a long time, so that the denervated muscles atrophy as completely as possible. The method has this disadvantage that the operation is very radical and the chance that the animals survive is already small in itself. Moreover it is difficult to make the animals, which stood the operation, to survive for a long time. This requires constant care and supervision. Finally there is every chance that the isolated spinal segment dies off, even when the experimental animal remains alive.

Thus far Dr. TEN CATE and myself succeeded once in keeping alive a dog, operated in the above-mentioned way, during more than six months.

The results of this and similar experiments, as far as the study of the functions of an isolated spinal segment are concerned, will be reported later by Dr. TEN CATE and myself.

Now I want already to communicate the result of the experiment in connection with the problem of myorhizomerism.

In a dog (series I. S. No. 3, called "Puck") one segment in the caudal