IV.—*A Defence of Turner's method of Detecting Boracic Acid.*

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A DEFENCE of Turner's method* seems at first sight to be quite unnecessary, for his test has been used over and over again, for upwards of fifty years, and, as far as I am aware, its usefulness has never been questioned till quite lately. Great was my surprise a few days ago to read a paragraph "On the uselessness of Turner's flux as applied to the detection of boracic acid."† Professor Chapman speaking of Turner's method, says:—"This test is much quoted in blowpipe books, and works on chemical analysis generally; but it is altogether superfluous. With borate of soda it fails entirely, or yields very unsatisfactory results; and although it answers for most other borates, and for borosilicates, it is uselessly applied to them, because these bodies colour the flame equally well *per se.*" He quotes from Buzengeiger (*Annales des Mines*, 1829, tome v. p. 36), in support of these statements.

Surely, I said to myself on reading the article, the careful Plattner and my good friend and most painstaking teacher, Prof. Theodor Richter, would never have recommended Turner's method if they had not been convinced of its value. Besides, I have so often used the test myself with such marked results, that I feel quite satisfied that it is a useful one.

However, to fortify my conviction, and make quite sure that I have not been labouring under an optical delusion for the last seventeen years, I have lately made a series of tests, and I am glad to say that the reliance I have always placed on Turner's test does not appear to be unfounded.

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*It consists in heating on Pt. wire before the blowpipe the powdered mineral mixed with a flux made of 4½ parts of bisulphate of potash, and 1 part of finely powdered fluor spar. If boric acid is present the flame is colored green.

†On some blowpipe-reactions, by Prof. E. J. Chapman. Canadian Journal, October, 1876.

My first experiments were made with a view to combat Prof. Chapman's assertion that "with borate of soda it (Turner's test) fails entirely, or yields very unsatisfactory results."

I suppose in speaking of "borate of soda," he refers to borax, and not to the neutral borate.

I first prepared some mixtures of borax and orthoclase, and then another series of borax and common salt. Some of the experiments were as follows:—

1. Borax mixed with 3 times its volume of Turner's flux, heated on Pt. wire in flame of Bunsen burner, imparts a very decided green colour to the flame.

2. Mixture of 97 parts by weight of orthoclase and 3 parts of borax, treated with flux in the same way. Distinct green coloration.

3. Mixture of equal parts by weight of borax and common salt, treated with flux in the same way. Decided green flame.

4. Mixture of 9 parts by weight of common salt and 1 part of borax, treated as before. Flame plainly coloured green.

5. Mixture of 98 parts by weight of common salt and 2 parts of borax, treated as before. By holding the Pt. wire close to the flame of the Bunsen burner, without quite touching it. I managed to tinge the edge of the flame a distinct green.

6. Mixture of 99 parts by weight of common salt and 1 part of borax, treated as before. By very carefully approaching the assay to the flame, I obtained a decided green coloration

As is well-known, the green coloration does not last long, but it is very plain and characteristic.

The facts I have just brought forward are surely sufficient proof of the delicacy of Turner's test, even in the presence of large quantities of sodium. In mixture No. 6 I only had 1 per cent. of borax, or about $\frac{1}{3}$ per cent, of boric acid ($B_2 O_3$), and yet I succeeded in obtaining a distinct reaction.

In all the above experiments I used a Bunsen burner, but as Prof. Chapman speaks of testing with the blowpipe flame, I tried several of my mixtures in that manner.

With No. 6 I failed to obtain a satisfactory coloration, but Nos. 4 and 5 gave a decided green. I need hardly say that to prevent any possibility of error on my part, I tested my Turner's flux alone and mixed with salt, and in neither case did I see any green tinge. Before using a piece of Pt. wire, I invariably tried it in the Bunsen flame alone, and with Turner's flux, so as to make sure of its being perfectly clean.

Prof. Chapman's second assertion that most of the borates (save sodic borate) and boro-silicates colour the flame equally well *per se*, as when mixed with Turner's flux, does not at all agree with the results that I have obtained on various occasions.

I made some comparative tests as follows:—I pulverized some schorl and made part of the powder into a paste with water, and mixed the rest with Turner's flux, I then tested the two on Pt. wires simultaneously, at the opposite sides of the flame of the same Bunsen burner. The schorl alone gave at most a greenish yellow coloration, whilst when mixed with the flux, the green tinge, though evanescent, was very vivid.

Axinite treated *per se* before the blowpipe, in a darkened room, gives, it is true, a yellowish green colour to the flame, but the colour obtained by the use of Turner's flux is *to my eyes* far greener and more intense.

Axinite *per se* in the flame of the Bunsen burner does not give such decided results as in the blowpipe flame, but with Turner's flux I had not the slightest difficulty in securing a marked green coloration.

Such being the results of my experiments, I am almost at a loss to account for Prof. Chapman's statements. Two solutions of the difficulty may be suggested.

1. Prof. Chapman does not apply the test in exactly the same manner as I do. Having carefully prepared Turner's flux in accordance with Plattner's directions,* I invariably thoroughly incorporate 3 volumes of the flux with 1 volume of the finely pulverized mineral by *grinding the two together* in an agate mortar. I sometimes make the mixture into paste with water, and plaster it on to the loop of the Pt. wire; or else heat the Pt. wire, and dip it into mixture. On holding the assay at the tip of the blue flame before the blowpipe, or in the flame of the spirit lamp, or Bunsen burner, a vivid green colour appears, if boric acid is present, but as said before, the coloration lasts but a short time.

2. It is possible that the colour afforded by fluo-boric acid does not produce the same effect on the eyes of Prof. Chapman as it does upon those of most people. Berzelius himself was well aware

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* **Plattner's Probirkunst mit dem Löthrohre, 4te Auflage, 1865, p. 466.**

of the fact that two persons do not always apply the same name to a certain colour. "For instance" he says, "Gahn would call a tint yellow or dark yellow which I should have called red, although we both agreed in the case of the pure primary colour, whether yellow or red."* This will, perhaps, explain to Prof. Chapman why Berzelius says nothing about the coloration afforded by certain minerals when treated before the blowpipe. It does not follow that he "overlooked the coloration of the flame," but knowing that some of his observations differed from those of his master, Gahn, he may have thought it better to omit the impressions produced on his eyes by certain flames, fearing that they would not agree with those produced on other people.

Of course, I do not for a moment impugn the accuracy of Prof. Chapman's results as far as he is individually concerned, but I still think that by the majority of blowpipe workers, or "pyrologists," as my friend Major Ross dubs us, Turner's test will be found to be eminently satisfactory.

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* Translated from Berzelius' *Anwendung des Löthrohrs* Nürnberg 1821, p. 79.