Chemical Tests on Streaks as a Rapid Aid to Mineral Identification

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Abstract

It is pointed out that although mineral streaks are very reactive, the application of chemicals to such streaks as a simple and rapid aid to identification has received but scant attention in the past. The techniques used by the writer are briefly described and the merits and demerits of the general analytical method are noted. Practical details are given for the identification of a number of ions.

Introduction

Whilst the colour of a mineral streak on unglazed porcelain or similar material has long been used as a rapid and simple aid to mineral identification, comparatively little has been published on the application of chemical tests to streaks as a further aid. This is surprising, as the streaks of minerals are extremely reactive.

Weyl (1942) states in a short note that "reactive" alumina in bauxitic material could be evaluated by streaking on vitrified, unglazed floor-tile and immersing in a 0.4% solution of morin in methyl alcohol for two minutes, followed by washing in water and examination under ultra-violet light. A positive streak fluoresces green and the intensity is an indication of the reactive alumina content. The same writer also observes that the chemical "development" of colourless streaks has a wide application and that lead and zinc ores, for example, can easily be recognised by a proper choice of chemicals.

Feigl (1947) also suggests the application of chemicals to streaks in order to facilitate the identification of a few substances. (See, for example, pp.305, 464 and 471.)

For several years the present writer has worked on chemo-streak tests and this paper is a résumé of some of his findings. A fuller account will be published elsewhere.

Methods

Most of the tests are conducted on small portions of unglazed, well-vitrified floor-tile, but a few are carried out on small pieces of sheet metal and on ground-glass microscope slides. Usually the chemicals are applied as solutions to a "strong" streak of the mineral under examination, but sometimes solids are rubbed over the streak. In some instances the "plate" on which the streak is to be made is "conditioned" by the application of solid or liquid reagents. Normally no external source of heat is required, but a few tests depend on the use of a blow-piped flame and a few others on the flame from a match or lighter. Occasionally a rapid fusion technique can be used to advantage (as, for example, during the examination of minerals for manganese) and this is described later. Certain other techniques may, on occasion, be employed advantageously and some of these are noted in the section dealing with specific tests.

Advantages and Disadvantages

The favourable characteristics of these tests are :—

1. They often provide the most rapid means available for determining whether a given element or radical is present or absent in a mineral.

2. A large number of the economically important minerals of hardness less than 6 can be examined by one or other of the techniques.

3. The tests often permit rapid differentiation between similar minerals.

4. The techniques are simple and easily mastered.

5. The tests are very economical because the quantities of reagents used are very small and the apparatus required is inexpensive.

6. To carry out most of the tests no external source of heat other than that of a match or a cigarette lighter is required — a distinct advantage in the field.

The disadvantages of the method are :—

1. It cannot be applied to minerals of hardness greater than about 6.

2. It cannot be used for most of the economically important minerals which require a preliminary fusion before being tested.

3. The method is unsuitable for the examination of small quantities of material.

Practical Details for the Detection of Certain Ions and the Differentiation of Certain Minerals

To save space the formulae of minerals are omitted and the chemistry of the various reactions is not discussed. Whenever reactions are employed which are described by Feigl in "Spot Tests" (1947), reference is made to this book rather than to the original literature.

Almost without exception the tests described below are new in that they have not before been carried out under the conditions specified. Indeed, many of these tests could not be effected successfully were it not for the enhanced reactivity which is exhibited by mineral streaks.

As minerals developed in the zone of oxidation are those most likely to be encountered when prospecting, tests applicable to these have been given prominence in the following selection.

ANTIMONY

1. **Potassium Hydroxide Test.** (Short, M.N., 1940, p.120.)

Antimony Minerals Tested :—Jamesonite. Kermesite. Stibiconite. Stibnite.

Procedure and Results. Streak the mineral on a portion of tile. Add a drop of 40% aqueous KOH. The kermesite and stibnite streaks immediately become yellow, whilst the other streaks are unchanged.

2. **Yellow Ammonium Sulphide Test.**

Antimony Minerals Tested :—Bindheimite. Stibiconite. Valentinite.

Procedure and Results. Place a drop of conc. HCl on a portion of tile and streak the mineral on the damp surface. Press the streak for c. 5 seconds on to a piece of drop-reaction paper impregnated with yellow ammonium sulphide. Both the streaks and the prints of cervantite and valentinite turn orange whilst those of bindheimite turn black. If the cervantite is admixed with limonite both the streak and the print will be dark grey to black initially, but after a few minutes they become orange.

3. **To differentiate between stibnite and jamesonite.**

To a streak on a portion of tile add a drop of conc. HNO_3. The jamesonite streak disappears (or becomes white) whilst the stibnite streak is unchanged.

BISMUTH

Cinchonine/Iodide Test. (Feigl, F., 1947, pp.59-60.)

Bismuth minerals reacting positively :—Bismite. Bismutite.

Procedure and Results. Streak on a portion of tile and add a drop of cinchonine/iodide reagent. Streaks of most oxide specimens thus treated become slightly orange whilst most carbonate streaks become strongly orange. If the streak is treated with a drop of 1 : 10 HCl **before** the addition of the reagent both oxide and carbonate streaks immediately assume an intense orange colour.

Cinchonine/Iodide Reagent. Dissolve 1 g. cinchonine in 100 ml. of water containing a little HNO_3. (It is necessary to warm.) Cool, and add 2 g. KI.

Other Notes. Under these conditions streaks of certain secondary copper minerals assume a brown colour whilst those of certain secondary lead minerals become yellow.

COBALT

Ammonium Thiocyanate/Acetone Test. (Ditz, H., 1901, p.110 ; 1922, p.121 ; 1934, p.97. Kolthoff, I. M., 1930, p.176.)

Cobalt Minerals Tested :—Asbolite. Bieberite. Erythrite. Sphaerocobaltite.

Procedure and Results. Print the streak by pressing it for two minutes on spot-reaction paper damped with 1 : 7 HNO_3. Then add a drop of a saturated solution of ammonium thiocyanate in acetone. Cobalt is indicated by the development of a blue print which may take about 30 seconds to reach its maximum intensity and which persists for only a few minutes.

COPPER

The vast majority of secondary minerals react positively to the three following tests.

1. Sodium Xanthate Test.

Procedure and Results. Streak on a portion of tile and add a drop of 10% sodium xanthate solution. Copper is indicated by the streak immediately becoming yellow.

2. Rubeanic Acid Test. (Feigl, F., 1947, pp.70-72.)

Procedure and Results. Streak on a portion of tile and add a drop of a 1% alcoholic solution of rubeanic acid followed by a drop of 0.880 ammonia. Copper is indicated by the streak becoming olive-green to greenish-black.

Other Notes. Under these conditions the streaks of certain cobalt minerals become brown whilst those of certain nickel minerals turn pale-blue.

3. Potassium Ferrocyanide Test.

Procedure and Results. To a streak on a portion of tile add one drop of a 5% solution of potassium ferrocyanide followed by a drop of 5N. HCl. Copper is indicated by the streak becoming reddish-brown.

Other Notes. The development of a blue colour, due to the presence of " reactive " iron in the tile and/or in the mineral under test, does not — in the writer's experience — obscure the brown colour of the copper compound.

Silver Nitrate Test.

This test enables differentiation to be made between cuprite and similar red minerals and between chalcocite and similar grey minerals.

Minerals Tested :—Bornite. Bournonite. Chalcocite. Chalcopyrite. **Cinnabar.** Copper. **Cuprite. Hematite.** Jamesonite. **Kermesite.** Marcasite. Niccolite. Pyrite. Stannite. Stibnite. Tetrahedrite. ("Red" species are in heavy type.)

Procdure and Results. To a streak of the mineral on a portion of tile add a drop of 0.1 N. silver nitrate.

(i) **Native Copper.** The streak becomes black immediately and particles of silver may be seen under the magnifying glass.

(ii) **Cuprite.** The streak becomes brownish-black and some silver is apparent.

(iii) **Chalcocite.** The streak rapidly becomes grey and metallic on account of a heavy precipitation of silver.

(iv) **Bornite.** Reacts as chalcocite but the change is less rapid.

(v) **Other Minerals Noted Above.** No obvious change.

FLUORINE

Zirconium-Alizarin Test. (Feigl, F., 1947, pp.202-204.)

Fluorine Minerals Tested :—Cryolite. Fluor-apatite. Fluorite. Pachnolite.

Procedure and Results. Streak on a portion of tile and print by applying it to a piece of spot-reaction paper which has been just previously damped with a few drops of zirconium/alizarin reagent. After two minutes the presence of the fluoride ion in all the above species is indicated by a yellow to white print on the pink, reagent-stained paper.

Reagent. Dissolve 0.05 g. of zirconium nitrate in 60 ml. of 1 : 5 HCl and add to a solution of 0.05 g. of sodium alizarin sulphonate in 50 ml. of water.

Other Notes. Soluble sulphates, phosphates and arsenates react similarly, but "mineral" phosphates and arsenates, because of their comparative insolubility, do not normally interfere if the test is conducted in the manner indicated.

IRON

Potassium Ferrocyanide Test.

Probably all secondary iron-rich minerals, excepting hematite and some limonites, react positively to this test.

Procedure and Results. Add a drop of 5% potassium ferrocyanide to a streak on a portion of tile and then add a drop of conc. HCl. Iron is indicated by the development of an intense blue streak (and halo).

LEAD

Potassium Iodide Test.

All secondary lead minerals yet tested react positively to this test.

Procedure and Results. Add a drop of strong and freshly prepared potassium iodide solution to a streak on a portion of tile. When the solution has largely sunk into the tile add a drop of 1 : 7 HNO_3. Lead is usually indicated by the streak becoming an intense yellow. However, the wulfenite streak changes from yellow to green and after about ten minutes it becomes blue. The red minium streak becomes dark brown and the brown plattnerite streak becomes appreciably darker.

MAGNESIUM

Titan Yellow Test. (Kolthoff, I. M., 1927, p.254.)

Magnesium Minerals Tested :—Bloedite. Brucite. Carnallite. Dolomite. Garnierite. Hydromagnesite. Magnesite. Periclase. Polyhalite. Steatite.

Procedure and Results. Streak on a portion of tile and add a drop of 0.1% Titan Yellow followed by a drop of 5N. sodium hydroxide. The presence of magnesium is indicated by the streak becoming pink to vermilion. All the above species react positively but some varieties of steatite do not do so.

MANGANESE

Sodium Peroxide Fusion Test.

All manganese-dominant species which are soft enough to give streaks react positively to this test.

Procedure and Results. Streak on a portion of tile. Cover the streak with sodium peroxide and apply a **burning** splint. The development of a blue-green fusion product indicates manganese.

MERCURY

Aluminium Amalgam Test.

Mercury Minerals Tested :—Calomel. Cinnabar. Montroydite. Livingstonite.

Procedure and Results. Streak on an aluminium sheet and after a few minutes examine, preferably through a magnifying glass. The presence of an aluminium-oxide, fungoid-like growth, proves the presence of mercury in all the above species.

MOLYBDENUM

Potassium Ethyl Xanthate Test. (Feigl, F., 1947, pp.93-94.)
Molybdenum Minerals Tested :—Molybdic Ochre. Wulfenite.

Procedure and Results. Streak on a portion of tile, then place a small crystal of potassium ethyl xanthate on the streak and add a drop of 5N. acetic acid. The presence of molybdenum in the above species is indicated by the development of a reddish-purple colour.

NICKEL

Dimethylglyoxime Test. (Feigl, F., 1947, pp.114-117.)
Nickel Minerals Tested :—Annabergite. Bunsenite. Garnierite. Morenosite. Zaratite.

Procedure and Results. To the streak on a portion of tile add a drop of 0.880 ammonia and then a drop of a 1% alcoholic solution of dimethylglyoxime. Nickel is indicated by the streak becoming rose-red. All the above species react positively.

SILVER

Dimethylglyoxime Test. (Feigl, F., 1947, pp.302-303.)
All silver halide minerals react positively to this test.

Procedure and Results. Streak the mineral on a portion of tile and add a drop of the reagent. Silver halide is indicated by the streak becoming red immediately.

Reagent. Immediately before the test prepare the reagent by mixing equal volumes of $K_2Ni(CN)_4$, 1% alcoholic dimethylglyoxime and 0.880 ammonia. The $K_2Ni(CN)_4$ is prepared by boiling KCN solution with such a quantity of $Ni(CN)_2$ that only a portion of the latter dissolves.

SULPHUR

Sulphides.

Sodium Azide/Iodine Test. (Feigl, F., 1947, pp.226-230.)
This test is specific for sulphide sulphur when dealing with minerals.

Procedure and Results. Streak on a piece of ground-glass or porcelain and add a drop of sodium azide/iodine reagent. The immediaite evolution of bubbles proves the presence of sulphide.

TELLURIUM

Tin/Sulphuric Acid Test. (Low, A. M., Weinig, A. J. and Schoder, W. P., 1945, p.20.)
Tellurium Minerals Tested :—Calaverite. Nagyagite. Petzite. Sylvanite. Tellurium.

Procedure and Results. Streak the mineral on a piece of sheet tin (or on the lid of a tobacco tin). Add a drop of conc. H_2SO_4 and warm with a match or cigarette lighter. Tellurium in the above species is indicated by the development of a reddish-purple solution.

TUNGSTEN

Zinc/HCl Test.

All tungsten-rich minerals, excepting members of the ferberite-wolframite-hübnerite series, react positively to this test.

Procedure and Results. Cover the streak on a portion of tile with zinc powder. Add a few drops of conc. HCl and then wash off the remaining zinc immediately. Tungsten is indicated by the streak becoming a strong blue.

Other Notes. Wulfenite and molybdic ochre may yield a slightly blue streak under these conditions.

URANIUM

Potassium Ferrocyanide Test.

In the absence of copper and molybdenum this test may be used to confirm the presence of uranium in most, if not all, uranium species developed in the oxidation zone.

Procedure and Results. Streak on a portion of tile and add a drop of 1% potassium ferrocyanide followed by a drop of 5N. HCl. In the absence of Cu and Mo, uranium is indicated by the streak becoming brown.

VANADIUM

Potassium Ferrocyanide Test. (Heinrich, C. F. J., 1949, pp.160-161.)
Vanadium Minerals Tested :—Calcio Volborthite. Descloizite. Turanite. Vanadinite.

Procedure and Results. Streak on a portion of sheet zinc and add a drop of 5N. HCl. After about ten seconds add a drop of 1.0% potassium ferrocyanide and warm by applying a burning match to the under-surface of the sheet. The presence of vanadium in all the above species is indicated by the zinc ferrocyanide precipitate becoming pale-pink to rose-red.

ZINC

Ferricyanide/Oxalic Acid/Diethylaniline Test.
(Feigl, F., 1947, pp.137-139.)

Zinc Minerals Tested :—Goslarite. Hemimorphite. Hopeite. Hydrozincite. Parahopeite. Smithsonite. Sphalerite. Tarbuttite. Willemite.

Procedure and Results. Streak on a portion of tile and add a drop of the reagent. Zinc is indicated by the streak becoming orange, vermilion or deep red. With the exception of sphalerite, all the species noted above react positively.

Reagent. Immediately before the test mix equal volumes of 3% potassium ferricyanide with a 0.5% solution of diethylaniline in 3% oxalic acid.

Other Notes. 1. Probably this test is capable of identifying zinc in any zinc species formed in the zone of oxidation provided that it does not contain appreciable quantities of ions which form coloured insoluble ferrocyanides.

2. The test is of the utmost value in differentiating rapidly between white (or near white) secondary zinc minerals and other white minerals with which they are commonly associated.

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