ART. XII.—*On Glucinum and its Compounds;* by CHARLES A. JOY, Professor of Chemistry in Columbia College, New York.

THE distinguished crystallographer, Haüy, having discovered a perfect identity in crystalline form, hardness, and specific gravity between the minerals beryl and emerald, requested Vauquelin to subject the former to a careful analysis. Beryl had previously been analyzed by Bindheim in 1790, with the following result:

SiO_3=64, Al_2O_3=27, CaO=8, and Fe_2O_3=2. Total 101.

Vauquelin[1] fused 100 parts of finely pulverized beryl with 300 parts of caustic potassa, and separated the silica (69 p. c.) in the usual way. He then precipitated the earths by carbonate of potassa, and digested the precipitate in caustic potassa, by which a portion, amounting to nine per cent, was again thrown down.

This property of re-precipitation from caustic potassa, in one portion of the beryl, attracted his attention, and the fact that he could not obtain an alum with it, when its sulphate was mixed with the sulphate of potassa, lead to the final discovery of glucina.

Vauquelin did not give a name to the new earth, but left it to his colleagues to propose one. In consequence of its forming salts of a sweetish taste, they called it *glucina*, from γλυκύς, sweet, γλυκύ, sweet wine, γλυκαίνω, to render sweet. The German chemists, however, have preferred the name *berylla*, from the mineral in which it was first found.

Since the days of Vauquelin, a number of minerals containing glucina have been added to the list. The following catalogue of these minerals, together with the literature of the subject, is believed to be tolerably complete.

1. *Alexandrite*—same as chrysoberyl.

2. *Alvite.*—Dana, Sup. iii, 5. Nyt. Mag. f. Nat., xiii, D. Forbes and T. Dahll.

3. *Aqua-marine.*—Vauquelin, Ann. de Chim. et Phys., [1], xxvi, 155. Hermann, Ann. de Chim. et Phys., [2], xix, 361. Don Pedros, magnificent specimen of, British As. f. Adv. Sci., i, 86. Du Menil, Schwgg. J., xxxiv, 454. Dana, Min., 178. Rammelsberg, Hdb. d. Min. chem., 553. Hausmann, Min., 603, 887.

4. *Beryl.*—Plin. Hist. Nat., xxxvii, 5, s. 20. Hard., ii, 776. Irenæus contra hæreses Ed. Ren. Massuet., 1710, Lib. i, proem. § 2, p. 2. Theophrast. de lapid., §§ 44, 45, 46. Klaproth, Beiträge. i, 9, iii, 215. Werner, 40, 41. Haüy, Traité, ii, 504. Gren., J. d. Phys., ii, 421, 1795. Graf v. Veltheim, Sammlung einige Aufsätze histor. antiquar. Miner. u. Abnl. Inhalts., 1800, ii, 134. Carl Ritter, Erdkunde, i, Africa, 2 A., 673-677. Beckmann's Beitr. z. Gesch. d. Erfind., iii, 297. Wilken, Gesch. d. Kreuzzüge. Beil. 8. Du Menil, Schwgg. J., xxxiv, 454; id. xxxix, 487. Fusion of beryl, Schwgg. J., xviii, 237; id., xix, 320. Apatite mistaken for beryl (απατάω, to deceive). Gilbert, J. d. Phys., xvi, 126 and 250. Hausmann, Handb. d. Min., ii, 603. Von Leonhard, Handb., 391. Beud. Traité, ii, 41. Phillips, Min., Brooke and Miller, p. 336. Ausserord, Beilage zur Augsb. Allgem.

[1] Ann. de Chim., [1], xxvi, 155, Feb. 15, 1798.

Zeitung, 1844, No. 347. Brugman, chromoxyd in beryl magnetic. Gilbert, J. d. Phys., iv, 33. Romé de l'Isle, Cristallogn., ii, 245. Blumenbachii spec. hist. nat. antiquae artis oper. illustrat., 1808, p. 31. Berzelius and Gahn, Schwgg. J., xvi, 265; id., xviii, 237. Berzelius and Klaproth, Schwgg. J., iv, 66. Bornträger, Leonh. u. Bronn's Jahrb., 1851, 185, and Liebig u. Kopp, Jahrb., 1851, 779. Breithaupt (Plattner, Lampadius), J. f. p. Chem., x, 249. Ditto, Schwgg. J., lx, 422. Hofmeister, J. f. p. Chem., lxxvi, 1. Kopp, Jahresb., 1859, 778. Lewy, Ann. Chim. Phys., [3], liii, 5. Mallet, Am. J. Sci., [2], xvii, 180. Mayer, Leonh. u. Bronn's Jahrb., 1851, 674. Liebig u. Kopp, Jahrb., 1851, 779. Moberg, Acta Soc. Scient. fennic., ii, 71. Berz. Jahrb., xxiv, 313. Müller, J. f. p. Chem., lviii, 180. Scheerer, Pogg. Ann., xlix, 533. Schlieper, Ram. Handb. d. Min., 555. Schneider, id., 555. Thomson, Outlines of Min., i, 399. Vauquelin, Ann. de Chim. et Phys., [1], xxvi, 155. Gilbert, Ann., xvi, 250. Jour. des Mines, No. xxxviii, 97; No. xliii, 563. Moore's Ancient Mineralogy, 146-150. Dana's Min., 178; 2d Sup., 4; 4th Sup., 112; 5th Sup., 403; 9th Sup., 6. Am. J. Sci., i, 242; ib., iv, 39; ib., vi, 222; ib., xviii, 291; ib., xl, 401; ib., [2], xiii, 264; ib., [2], xvii, 78. Von Kokscharow, Min. Russ., ii, 356. Zippe, Geschichte d'Met., 558. Sir David Brewster, Phil. Trans., 1819. Gilbert, Ann., lxv, 5; ib., lxix, 1; ib., lxix, 535. C. G. Gmelin, Pogg. Ann., l, 175. Awdejew, Pogg. Ann., lvi, 101. H. Rose, ib., lix, 101. Salm Horstmar, Pogg. Ann., lxxxvi, 145. Hermann, Ann. de Chim. et Phys., xix, 361; ib., xliv, 27; ib., lxii, 284; ib., xl, 109; ib., lix, 178. Journal des Mines, Jan., 1812. Gilbert, J. d. Phys., xliii, 110. Schwgg. J., xxxi, 261; ib., xxxiv, 454. Cleaveland's Min., 274–278. Kopp, Gesch. d. Chem., iv, 68. K. K. Russ. Gesel. d. Min., i, 343, 1842.

5. *Chrysoberyl.*—Haüy, Traité, ii, 303. An. de Mus. d'Hist. Nat., 1811, xviii. Gilbert, Ann., xli, 53, from Haddam, sent to Haüy by Mr. Bruce of New York, 1810. Hausmann, Min., ii, 430. Henry Seybert, Trans. Am. Phil. Soc., March 5, 1824, p. 116. Schwgg. J., xlii, 228. Thomson's Outlines, i, 400. Awdejew, Pogg. Ann., lvi, 118. Ann. Chem. Pharm., xliv, 270. Plinius, xxxvii. Hard, ii, 776. Klaproth, Beit., i, 97. G. Rose, Pogg. Ann., xlviii, 570. G. Rose, Reise nach dem Ural, ii, 379. Pott, K. K. Gesl. f. d. gesam. Min. St. Petersburg, i, 116. Werner, 5. V. Leonhard, Handb., 539. Beud., Traité, ii, 145. Mohs, Phys., 342, fig. 37. Damour, Ann. Ch. Phys., [3], vii, 173. Pogg. Ann., lix, 120. Dana's Min., 122. Moore's Anc. Min., 151. Jameson's Min., i, 202. Arfvedson, Vet. Acad. Hand., 1822. Schwgg. J., xxxviii, 4. Bergemann, Dissertat. Göttingen, 1826. Artificial, Caron and Deville, Ann. Chem. Pharm., cviii, 57. Rose, ib., lxiv, 287. Ebelmen, ib., lxviii, 265; ib., lxxx, 207. Am. J. Sci., [1], ii, 240; ib., iv, 37. Haidinger, Pogg. Ann., lxxvii, 228. Schwgg. J., l, 329; ib., li, 251. Cleaveland, Min., 204.

6. *Cymophane*—same as chrysoberyl.

7. *Davidsonite*—same as beryl, Phil. Mag. [4], xii, 386. Ann. Chem. Pharm., xix, 154.

8. *Emerald.*—Haüy, identity of emerald and beryl, Ann. Chim. Phys., xxvi, 156. Vauquelin, Ann. Chim. Phys., xxvi, 264. Am. J. Sci., [1], ii, 354. Klaproth, Beitr., iii, 215. Chemical Essays, London, 1801, 176. Moberg, Acta. Soc. Sci. Fenn., ii, 81. Ville, Comp. Rend., xli, 698. Lewy, ib., xlv, 877. Ann. Chim. Phys., [3], liii, 51. Rép. Chim. Appl., 1858–59, 27. Du Péron, Ann. Chim. Phys., xxiii, 68; ib., xiv, 64. Dumas, Séances de l'Acad., 1855. De Senarmont, ib., 1859. Dana's Min., 178. Cleaveland's Min., 274. Hausmann's Min., 603.

9. *Euclase.*—Vauquelin, J. des Mines, No. 28, 258. Haüy, Traité, ii, 528. Werner, 39. Beud, Traité, ii, 32. Mohs' Phys., 351. Weiss, Verhand d. Gesells. Natf. F., Berlin, 1820, 110. Weiss, Abhd. k. Akad. d. W., Berlin, 1841, 249. Berzelius, Schwgg. J., xxvii, 73. Schabus, Monograph. Wien Ak. d. W., 1852. Pogg. Ann., lxxxviii, 608. Kokscharow, Pogg. Ann., ciii, 348. Bulletin de l'Ac. de St. P., xvi, 284. Material zu Miner Russ., iii, 131. Hausmann, Handb. d. Min., 601. Von Leonhard, Handb., 395. Levy, Edin. Phil. J., xiv, 129. Mallet, Phil. Mag., [4], v, 127. J. f. p. Chem., lviii, 447. Damour, Comp. Rend., xl, 944. J. f. p. Chem., lxvi, 154. Dana, Am. J. Sci., xvi, 96. Ann. Chim. Phys., xi, 216; ib., xii, 26. Dr. Brewster, Edinb. J., ix, 217. Gilbert's J., lxix, 1. Schwgg. J., xxxiii, 106. Zinken, Schwgg. J., xxvi, 372; xxvii, 73. Rammelsberg, Hdb. d. Min. Chem., 570. Cleaveland's Min., 278.

10. *Gadolinite.*—Berzelius, Schwgg. J., iv, 51; ib., xxiii, 194; ib., xxvi. Afhandl. i. Fys., v, 54. Thomson, Steel and Richardson, Phil. Mag., vii, 430. J. f. p. Chem., viii, 44. Schwgg. J., viii, 450. Thomson's Outl., i, 410. Ekeberg, Ann. Chim. Phys., xliii, 228. Gilbert's Ann., xiv, 247. Scheerer, J. d. Chem., iii, 187, 1794. Mém. de l'Akad. de Stock., 1797. Dana's Min., 211; 4th Sup., 119; 6th Sup., 351. J. f. p. Chem., lxxiv, 271. Von Kobell, Schwgg. J., 1834. Pogg. Ann., ciii, 314; ib., lix, 101. Berlin, Berz. Jahr. B., xvii, 220. Schwgg. J., xiv, 33; ib., xvi, 404; ib., xxi, 261. Connel, Edinb. n. Phil. J., June, 1836. Ann. Chem. Pharm., xlviii, 224. Pogg. Ann., li, 414; ib., lvi, 479. Klaproth, Beit., iii, 52; ib., v, 173. Ann. Chim. Phys., xxxvi, 143; ib., xxxvii, 87; ib., xliii, 278; ib., xlix, 124; ib., lxii, 208; ib., [2], ii, 411; ib., [2], iii, 26. Brcht. d. k. Akad. d. W., Berlin, 1801, p. 16. Hausmann, Min., 542, 1590. Geyer, Crell. Ann. d. Chem., 1788. Descloizeaux and Damour, Ann. Ch. Phys., [3], lix, 357. Cleaveland's Min., 205. Orthite and Gadolinite, Pogg. Ann., lix, 103. Berz. Jahrb., xxiv, 318; ib., xxv, 365.

11. *Goshenite*—same as beryl.

12. *Helvine.*—Vogel, Schwgg. J., xxix, 314. C. Gmelin, Pogg. Ann., iii, 53. Rammelsberg, Pogg. Ann., xciii, 453. Breithaupt, Gilbert's Ann., lxiv, 42. Dana's Min., 194; 1st Sup., 9. Hausmann's Min., 870. Werner, 23. Triesleben's Beiträge, i. Haüy, Traité, ii, 168. V. Leonh. Hab., 462. Beud., Traité, ii, 168. Mohs' Phys., 397, fig. 206.

13. *Leucophane.*

14. *Melinophane.*—Th. Scheerer, J. f. p. Chem., lv, 449. Greg, Phil. Mag., [4], x, 510, 1855. Descloizeaux, Ann. Chim. Phys., [3], xl, 76. Rammelsberg, J. f. p. Chem., lxviii, 245. Pogg. Ann., xcviii, 257. Berzelius's Jahrb., xxi, 168. Dana's Min., 182; 2d Sup., 13; 4th Sup., 121. A. Erdmann, Vet. Acad. Hand., 1840, 191. Awdejew, Ann. Chem. Pharm., xliv, 270. Phillips's Min., 356. Hausmann's Min., 888. Rammelsberg, Handb. Min. Chem., 763.

15. *Phenacite.*—Hausmann, Handb. d. Min., 538, 1590. Nordenskiöld, Pogg. Ann., xxxi, 57. K. v. Ac. H., 1823, 1860. Beirich, Pogg. Ann., xxxiv, 519; ib., xli, 323. Ann. Chem. Pharm., xvi, 251. Mohs' Phys., 353. R. Hermann, Bullet. Soc. Imp. Mos., 1844, iv, 877. Hartwall, Ann. Chem. Pharm., xiv, 82. Berz. Jahrb., xiii, 157. Pogg. Ann., xxxi, 57; ib., cxxxii, 120. Ann. Chem. Pharm., xvi, 251. Phil. Mag., [4], iii, 378. Dana's Min., 189. Am. J. Sci., [2], xvii, 78. G. Rose, Pogg. Ann., lxix, 143. Rammelsberg, Hdb. Min. Chem., 553. Awdejew, Ann. Chem. Pharm., xliv, 270. Deville, artificial, Ann. Ch. Pharm., cxx, 178.

16. *Smaragd*—same as beryl.

17. *Tyrite.*—Phil. Mag., [4], xiii, 91. Dana's 4th Sup., 129.

As my object was to procure a supply of glucina, a re-examination of the above minerals was not deemed necessary. One hundred pounds of fragments of beryl were obtained from Acworth, New Hampshire, and ground in a gold-quartz mill, and decomposed according to the following methods.

Methods for the decomposition of beryl.

1. By passing chlorine gas over a calcined mixture of lamp-black, oil, and beryl.

2. By treating beryl with concentrated hydrofluoric acid and sulphuric acid.

3. By digesting seven parts of beryl and thirteen parts of fluor spar in eighteen parts of concentrated sulphuric acid.

4. By fusing beryl with three parts of fluorid of potassium, and digesting in sulphuric acid.

5. By fusing beryl with fluorid of ammonium, and digesting in sulphuric acid.

6. By digesting fifty parts of beryl in thirty parts of sulphuric acid, and fusing with one hundred parts of ferrocyanid of potassium and seventy parts of chlorid of sodium.

7. By fusing beryl with fluor spar.

8. By fusing beryl with half its weight of caustic lime.

9. By fusing beryl with litharge.

10. By fusing beryl with binoxyd of manganese.

11. By fusing beryl with three parts of carbonate of potassa and two parts of carbonate of soda.

12. By fusing beryl with two parts of carbonate of potassa.

1. *By chlorine gas.*—Finely pulverized beryl was intimately mixed with lamp-black and linseed oil, and calcined. Chlorine gas was passed over it at a red heat in a porcelain tube, and the more volatile chlorids of silicon and iron driven into the receiver. The chlorids of glucinum and aluminum were collected in the further end of the tube. The beryl was completely decomposed. An unsuccessful attempt was made to take advantage of the difference in the points of volatilization of the chlorids of iron, silicon, aluminum, and glucinum, in order to separate them.

2. *By hydrofluoric acid.*—This well-known method was tried for comparison, and, where the beryl was finely pulverized, was entirely successful. The glucina was separated from the alumina by carbonate of ammonia.

3. *By fluor spar.*—This method was proposed by Scheffer.[2] Seven parts of beryl, thirteen parts of fluor spar, and eighteen parts of concentrated sulphuric acid were gently heated in a leaden trough under constant stirring, for two hours, and then transferred to an iron vessel, and heated sufficiently to expel the fluorid of silicon and the excess of sulphuric acid. The decomposition is fully accomplished in this way, and the only objections to it are the presence of so much sulphate of lime in the solutions, and the difficulty in expelling the excess of sulphuric acid.

4. *By fluorid of potassium.*—One part of beryl was fused with three parts of fluorid of potassium, and digested in sulphuric acid. If this flux could be obtained in sufficient quantity, the method would be preferable to all others, as the mass fuses easily, the fluorid of silicon is driven off at a gentle heat, and the potash alum crystallizes readily, carrying down all of the alumina, thus at the same time accomplishing the decomposition of the silicate and the separation of the alumina and glucina.

5. *By fluorid of ammonium.*—Four parts of beryl were intimately mixed with nine parts of fluorid of ammonium, gently heated in a capacious platinum crucible, and fused at a low red heat. The mass was covered with an excess of sulphuric acid,

[2] Ann. Chem. Pharm., cix, 144.

and evaporated, care being taken to prevent the formation of nearly insoluble fluorid of aluminum by too great heat.

This method[3] for the analysis of silicates is one of the best ever proposed, and, as fluor spar is abundant, there is no reason why it should not be frequently applied.

6. *By ferrocyanid of potassium.*—The method of Corbelli,[4] for obtaining aluminum from its compounds, was applied to beryl. Fifty grammes of beryl and thirty grammes of sulphuric acid were digested for two hours, and the heat raised to 500° C. After cooling, one hundred parts of dry ferrocyanid of potassium and seventy parts of chlorid of sodium were added, and the mass exposed to the highest heat of an anthracite fire. The result was a button of iron, but no glucinum. The beryl was only slightly decomposed. A trial with an alumina salt also yielded a button of iron, but no aluminum.

7. *By fusing with fluor spar.*—One hundred and eight parts of beryl and one hundred and sixty parts of fluor spar fused very readily, but required close attention to prevent the mass from running through the iron crucible. The complication in the separation of the earths, occasioned by the introduction of so much lime, was found to be inconvenient in this method.

8. *By caustic lime.*—Two parts of beryl and one part of caustic lime were fused in a hessian crucible. The mass melted readily, but, as in the previous example, required care to prevent it from running through the crucible. This method[5] is rapid, requires only a low heat and cheap material, and would be highly advantageous, if suitable crucibles could be provided. I modified it somewhat, as follows: by fusing one part of lime, two parts of beryl, and three and a half parts of gypsum. (Two and one and a half parts of gypsum were tried.) This readly decomposed the beryl, forming a beautiful glass, and did not run through the crucible; but so much lime in the solution was an objection.

9. *By litharge.*—One hundred grammes of beryl were intimately mixed with three hundred grammes of litharge in an iron crucible, and gradually heated to fusion. The mass was then stirred with an iron spatula, and poured upon a marble slab. The cold slag had a dirty yellow color, and was soft and easy to pulverize. It was reduced to a fine powder, moistened with water, digested in an excess of nitric acid, and evaporated to dryness. The silica was separated, and the filtrate was left until nitrate of lead had crystallized out. The balance of the lead was separated by sulphuric acid, and the requisite amount of sulphate of ammonia then added to form an alum with the sulphate of alumina. This method with litharge proved to be

[3] Rose, Pogg. Ann., cviii, 19.
[4] Rep. pat. inv., Oct. 1858, 300.
[5] Debray, Ann. Ch. Phys., [3], xliv, 5.

admirable, and is highly recommended for the decomposition of other silicates. The yield of glucina was not quite equal to that obtained for the fusion with carbonate of potassa.

10. *Binoxyd of manganese.*—Two parts of finely pulverized beryl were intimately mixed with three parts of binoxyd of manganese, and exposed to the highest heat of an anthracite coal furnace for two hours. The mass fused completely, affording a dark glass resembling obsidian, hard and difficult to pulverize. It was digested in concentrated sulphuric acid, and the silica separated as usual. The beryl was fully decomposed. My object was to see whether the binoxyd of manganese would decompose silicates in this way, and, further, to try if an alum with the *protoxyd* of manganese ($MnO, SO_3+Al_2O_3, 3SO_3+24HO$) could be formed. No such alum was obtained, thus confirming previous experiments in this direction.

11. *Carbonates of soda and potash.*—By fusing beryl with a mixture of two parts of carbonate of soda and three parts of carbonate of potassa, the mineral is easily decomposed, and, where the earths are separated by carbonate of ammonia or chlorid of ammonium, the method is very convenient. It has no advantages, however, over the succeeding and last method.

12. *By carbonate of potassa.*—One part of finely pulverized beryl and two parts of carbonate of potassa fused very readily in a platinum crucible. It will be seen, under the head of the separation of alumina and glucina, that this method was preferred to any other.

All of the above methods, and numerous others which it is not necessary to recapitulate, were subjected to repeated trials in my laboratory, and a large supply of glucina obtained for use in the further prosecution of this investigation.

Methods for the separation of glucina and alumina.

1. Chlorid of ammonium.
2. Carbonate of ammonia.
3. Caustic potassa.
4. Sulphurous acid.
5. Carbonate of baryta.
6. Hyposulphite of soda.
7. Decomposition of nitrates.
8. Acetate of soda.
9. Fusing with caustic potassa.
10. Formate of ammonia.
11. Decomposition of sulphates.
12. Potash alum.

1. *By chlorid of ammonium.*—The oxyds of iron, alumina, and glucina were precipitated by ammonia, and the precipitate digested in a concentrated solution of chlorid of ammonium, with constant replacement of the evaporated water. The iron and alumina, being insoluble in sal-ammoniac, are collected upon a filter, and the glucina precipitated from the filtrate by sulphid of ammonium.

This method, proposed by Berzelius,[6] was regarded by Wee-

[6] H. Rose, Handb. d. Analyt. Chem., ii, 61.

ren[7] as preferable to any other. My observations confirm the accuracy of the results to be obtained, if all of the precautions are observed, but the time required for the digestion of the mixture and the care to keep it at a proper concentration render it more tedious than other methods, without a corresponding increase in the yield of glucina.

2. *By carbonate of ammonia.*—The filtrate from the silica was dropped, with constant stirring, into a warm concentrated solution of carbonate of ammonia in excess, which precipitated the alumina and dissolved the glucina. The solution was left for some days in a corked flask, and occasionally well shaken. After separating the alumina by filtration, the glucina was obtained by distilling off the carbonate of ammonia and collecting on a filter. The carbonate of ammonia was thus saved for future operations. A serious objection to this method is the fact that considerable alumina is always dissolved in the presence of glucina, although alone it is not affected by carbonate of ammonia. I instituted a series of experiments in order to ascertain the degree of concentration of the carbonate of ammonia, and the length of time most favorable for the solution of the glucina.

One gramme of pure glucina was treated with carbonate of ammonia, under the same circumstances of temperature and concentration, for three, seven, eleven, and sixteen days. After ten days, with carbonate of ammonia of 1·080 specific gravity and 15° C., the maximum amount was dissolved. If the solution be kept longer than ten days, a precipitate of carbonate of glucina will begin to form, and at the expiration of sixteen days, fifteen per cent less of the original amount will go into solution. It was found advisable to separate the glucina after the expiration of a week. I observed that it was preferable to precipitate the two earths in the first instance with carbonate of ammonia, as the glucina was then more soluble than if first thrown down by ammonia and afterwards digested in the carbonate. Carbonate of potassa and carbonate of soda dissolve the precipitate of glucina, but with greater difficulty.

3. *By caustic potassa.*—This method was first proposed by C. G. Gmelin.[8] The solution of alumina and glucina in chlorhydric acid is neutralized by a cold solution of caustic potassa until the precipitate disappears; it is then largely diluted with water, and boiled in a platinum capsule for a quarter of an hour. The glucina will be precipitated, and must be carefully washed in hot water to free it of all traces of potassa.

By diluting the potassa with ten parts of water, and dissolving the glucina in chlorhydric acid, and re-precipitating by ammonia, I obtained very pure glucina, but always with loss of mate-

[7] Pogg. Ann., xcii, 91.

[8] Handwörtb. d. Chem., 2te Auf., ii, 1018. Pogg. Ann., xcii, 97.

rial, as a portion of the glucina remained in solution with the alumina, and where iron was present, I found that considerable quantities were dissolved by the potassa, notwithstanding every precaution was observed.

4. *By sulphurous acid.*—This method of Berthier,[9] founded upon the difficult solubility of the basic sulphite of alumina, did not succeed, as variable quantities of the sulphite of glucina were always thrown down with the alumina salt. The sulphite of ammonia was substituted for the sulphurous acid gas, but the result was the same. My observations confirmed the experience of Weeren[10] and Böttinger.[11]

5. *By carbonate of baryta.*—According to H. Rose,[12] carbonate of baryta does not precipitate glucina from cold solutions, while alumina under the same circumstances is precipitated. I found, however, in confirmation of the observations of Weeren,[13] that both glucina and alumina were precipitated.

6. *By hyposulphite of soda.*—Chancel's[14] method for the separation of alumina and iron was applied to the separation of alumina and glucina. Weighed portions of alumina and glucina were dissolved in chlorhydric acid, nearly neutralized by carbonate of soda, largely diluted, and to the cold liquid a slight excess of hyposulphite of soda added, and the whole boiled until fumes of sulphurous acid were no longer observed. It was found that the glucina was precipitated along with the alumina, and the method proved unavailing.

7. *By the decomposition of the nitrates of alumina and glucina.*—According to Deville,[15] if the nitrate of alumina be heated for some time to 200° and 250° C., all the nitric acid will be expelled, and a residue of granular alumina, insoluble in water, will be left in the capsule. Alumina can in this way be separated from BaO, SrO, CaO, KO, NaO, and MgO.

Weighed portions of the nitrates of alumina and glucina were heated together to 200° C., and afterwards treated with water. It was found that the nitrate of glucina was decomposed the same as the nitrate of alumina—affording no method for the separation of the earths.

8. *By acetate of soda.*—Alumina is precipitated from a boiling solution of acetate of soda, the same as the oxyd of iron, a method employed for the separation of alumina and iron from other bases. I found that the behavior of glucina was the same as alumina, and consequently this method was also unavailing.

9. *By fusing with caustic potassa.*—Weeren[16] says, if glucina

[9] Rose, Handb. d. Analyt. Chem., ii, 60. Berz. Jahrb., xiii, 148.
[10] Pogg. Ann., xcii, 99. [11] Ann. Chem. Pharm., li, 397.
[12] Rose, Handb. d. Analyt. Chem., ii, 57, 61.
[13] Pogg. Ann., xcii, 104.
[14] Comp. Rend., xlvi, 987. Ann. Chem. Pharm., cviii, 237.
[15] Ann. Chim. Phys., [3], xxxviii, 9. [16] Pogg. Ann., xcii, 106.

and caustic potassa be fused together, water dissolves out nothing, but if alumina be fused in the same way, it will be rendered soluble in water. This suggested a method for the separation of the two earths. Upon trial it was found that the glucina was equally soluble in water after fusion with caustic potassa.

10. *By formate of ammonia.*—Formate of ammonia precipitates iron, alumina, and glucina, and none of them are soluble in excess. This method was therefore not available.

11. *By the decomposition of sulphates.*—If sulphate of glucina be heated to redness, sulphuric acid and sulphur are driven off, and the pure oxyd remains. The sulphate of manganese is not decomposed by heat in this way. This method may be of application in the analysis of helvine, but can not be used to separate alumina from glucina, as the sulphate of alumina behaves, when heated, in the same manner as the sulphate of glucina.

12. *By the formation of potash-alum.*—One part of finely pulverized beryl was intimately mixed with two parts of carbonate of potassa, and fused in a capacious platinum crucible at an ordinary red heat. After cooling, concentrated sulphuric acid was poured over the mass, care being taken to prevent loss by effervescence, and the whole constantly stirred until it assumed a gelatinous condition. The excess of sulphuric acid was then expelled, and the silica determined as usual. The filtrate from the silica, containing the sulphates of alumina, glucina, iron and potassa, was concentrated by evaporation, and allowed to stand twenty-four hours, and sometimes longer, according to the amount of beryl taken, until a crop of alum crystals had formed. These were collected and washed, and the liquid evaporated until a second crop was gathered. The filtrate from the alum crystals was concentrated and poured into a hot saturated solution of carbonate of ammonia, and allowed to stand several days with frequent agitation. The insoluble portion was collected on a filter and digested a second time in carbonate of ammonia and afterwards in caustic potassa. The portion insoluble in caustic potassa was collected and weighed, and gave the percentage of iron. The filtrate from the iron was examined for alumina and yielded only traces, showing that all of the alumina was separated as alum. The glucina and alumina were determined as oxyds. This method was subjected to repeated trials, and was found to give better results than any other. The average composition of the beryl from Acworth, New Hampshire, determined in this way on a large scale, proved to be as follows: silica 68·84, glucina 13·40, alumina 16·47, sesquioxyd of iron 1·70. Total 100·41.

The consideration of the salts of glucina is reserved for a future communication.

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