inconclusive as to the presence of oxygen. However, from an examination of the known basic chlorides of lead and copper, it appears most probable that the true composition of the mineral is represented by the following formula:—

$$(Pb\,Cl + PbO) + (Cu\,Cl + CuO) + aq.$$

No salt having this composition has, so far as I am aware, been hitherto described.

XVII. *On Francolite, a supposed New Mineral.* *By* T. H. Henry, *Esq.*, *F.R.S.**

MR. BROOKE some years since received from Mr. Nuttall some specimens of a mineral found at Wheal Franco near Tavistock, Devon, which appeared to him and to Mr. Brooke to differ in external characters from all the substances with which they were acquainted, and it was consequently provisionally named Francolite.

It consists of small masses of irregularly formed and aggregated crystals, apparently hexagonal prisms of considerable lustre, and covering the matrix with a sort of mammillated surface. It has lately been found in another mine in larger and purer specimens, and I have at Mr. Brooke's request analysed a part of one of these.

A small crystal, perfectly free from the matrix, was found by means of the blowpipe to contain lime and phosphoric acid, and a portion reduced to powder and warmed with sulphuric acid corroded glass strongly. Iron and manganese were also detected; but a very minute trace of chlorine was found.

I determined with this mineral to employ the method lately recommended by Prof. H. Rose for the quantitative separation of phosphoric acid from all bases but alumina, by means of nitric acid and metallic mercury. The crystals were reduced to powder, and freed from the matrix (quartz with copper pyrites) by treatment in a stoppered bottle with very dilute nitric acid in the cold (one part of strong acid to nineteen of water), in which the mineral was perfectly soluble. The solution was evaporated to dryness with metallic mercury in a platinum dish heated by steam (the fluoride of calcium is hereby decomposed and the fluorine dissipated), and the remainder of the process conducted scrupulously according to the directions given by Rose†.

* Communicated by the Author.

† Poggendorff's *Annalen*, March 1849; or Chemical Gazette, vol. vii. p. 202–206.

The iron and manganese were separated from the lime by ammonia after the addition of bromine.

The separation of phosphoric acid was complete; not a trace could be discovered with the bases by means of molybdate of ammonia, nor could a trace of lime be discovered by treating the $2MgO, PO^5$ with sulphuric acid, evaporating and dissolving in alcohol.

The results obtained in two analyses from crystals from different parts of the specimen were in 100 parts,—

	I.	II.
Lime	53·38	52·81
Oxides of iron and manganese	2·96	3·22
Phosphoric acid	41·34	41·80
Fluorine and loss	2·32	2·17
	100·00	100·00

This composition corresponds very nearly to that of fluor apatite, $CaFl+3(3CaO, PO^5)$, in which the lime is partially replaced by the protoxides of iron and manganese. This composition would give per cent. (see Rammelsberg's *Handwörterbuch der Mineralogie*, p. 37),—

Lime	55·88
Phosphoric acid	42·02
Hydrofluoric acid	2·10
	100·00

And these analyses of Francolite confirm, by the direct estimation of the PO^5 by an accurate method, the results obtained by Gustave Rose in an elaborate investigation of several varieties of apatite from various localities, published many years ago*, in which the phosphoric acid was estimated from the loss.

XVIII. *On the Equation* $Q=q(w, x, y, z)=w+ix+jy+kz$. *By* William Spottiswoode, *M.A., of Balliol College, Oxford*†.

THE theorem expressed by the above equation is of considerable importance in the calculus of quaternions, and indeed essential for the application of that method to geometrical and physical problems. Sir W. R. Hamilton in his researches (Transactions of the Royal Irish Academy, vol. xxxi.), has effected the transformation by means of the symbolical division of numeral sets; but since nothing, which may throw light

* Poggendorff's *Annalen*, vol. ix.; and Berzelius, *Jahresbericht*, 1828.

† Communicated by the Author.