PHOSPHATE FIXATION BY SOIL MINERALS: MICA AND RELATED GROUPS

Alfred T. Perkins and H. H. King

The literature on phosphate fixation is voluminous. Among the publications reviewing the subject may be mentioned those of Torbyrn (3) and Midgley (5). Many other papers containing a review of the subject have been published, but they are not listed for lack of space.

Several methods of studying phosphate fixation have been outlined in the literature. They differ in detail, in results produced, and information obtained. That there is some question of the mechanics of phosphate fixation and that several forces are involved is evidenced by the literature on the subject. The method of studying phosphate fixation that has been selected for these studies will measure the amount of phosphate attracted by the soil (mineral) and held by the particles. The phosphate that will be taken down to the bottom of a centrifuge tube with the mineral is measured, even though part of this may be so weakly held that it can be washed out by water.

In previous studies of phosphate fixation with soil material as a basis of study, the authors of this paper have obtained data which is apparently contradictory. To simplify the system instead of soil material large crystals of a number of minerals commonly found in soils were obtained for the purpose of measuring their phosphate-fixing ability when various amounts of phosphate were applied over a range of pH values. These minerals were used in as pure a form as was reasonably possible, being selected for their original purity and then picked over by hand and an electric magnet when it was possible to increase their purity. These minerals were then ground with frequent sifting in a mullite mortar until they would pass through a 100-mesh sieve making the largest particles about 150 microns in diameter. As some of the softer minerals which appear in sheets, such as muscovite, were hard to grind in this manner, they were ground in a porcelain ball mill with porcelain pebbles. The material was frequently sifted to prevent a too finely ground mineral from being obtained. In each case the implement used to grind the mineral was harder than the mineral being ground. A check by a microscope indicated that the several minerals were ground to approximately the same average size. The ground material was centrifuged to obtain a clear supernatant liquid. That the concentration of phosphate in the wash water will be free from the phosphate ion.

The method chosen to measure phosphate fixation is simple. It indicates the amount of phosphate held immediately, either chemically precipitated or adsorbed by secondary or residual valences in the soil around the particle.

Five-gram portions of the 100-mesh mineral were ground into 100-ml centrifuge tubes, sufficient water was added to bring the final volume to 25 ml, then the amount of hydrochloric acid or sodium hydroxide required to adjust the desired pH value was added, and finally, the indicated amount of phosphoric acid as H$_3$PO$_4$ was added. The mixture was rotated in an end-over-end shaker for about 16 hours at a constant-temperature room at 25°C, after which the material was centrifuged to obtain a clear supernatant liquid.

The data collected and calculations made therefrom are similar in structure. Their detailed structure is given by Bragg (2, page 203), and, except for additional micas, are all of the minerals obtainable in pure form from these groups.

The relationship of the seven minerals reported on in this paper is close. With kaolin as a pattern, pyrophyllite as an aluminum salt might be considered to be a monohydroxy, disilicate compound rather than a dihydroxy, monosilicate.

The relationship between pyrophyllite and muscovite is that one structural silicon atom has been replaced by an aluminum atom with the extra valences satisfied by a potassium atom. The relationship between pyrophyllite and margarite is that two of the structural silicas have been replaced by aluminum with the extra valences satisfied by calcium.

Talc is like pyrophyllite, except that it is a magnesium rather than an aluminum compound, and phlogopite bears the same relationship to muscovite that magnesium has replaced the combined aluminum.

In biotite some ferrous iron has replaced part of the magnesium in phlogopite.

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The minerals reported on in this paper are pyrophyllite and talc; muscovite, phlogopite, and biotite of the mica group; margarite of the clintonite group; and kaolinite of the kaolinite group. These are similar in structure. Their detailed structure is given by Bragg (2, page 203), and, except for additional micas, are all of the minerals obtainable in pure form from these groups.

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