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REFERENCES

- 1. El-Swaify, S.A. "Structural Changes in Tropical Soils Due to Anions in Irrigation Water." Soil Science 115 (November 16, 1971): 64-70.
- 2. Mekaru, T., and Uehara, G. "Anion Adsorption in Ferruginous Tropical Soils." <u>Soil Science Society of America Proceedings</u> 36(1972): 296-300.
- 3. Gebhardt, H., and Coleman, N.T. "Anion Adsorption by Allophanic Tropical Soils. I Chloride Adsorption." <u>Soil Science Society</u> of <u>America Proceedings</u> 38(1974): 255-259.
- 4. Gebhardt, H., and Coleman, N.T. "Anion Adsorption by Allophanic

 Tropical Soils. II Sulfate Adsorption." Soil Science Society

 of America Proceedings 38(1974): 259-262.
- 5. Gebhardt, H., and Coleman, N.T. "Anion Adsorption by Allophanic

 Tropical Soils. III Phosphate Adsorption." Soil Science

 Society of America Proceedings 38(1974): 263-266.
- 6. Kamprath, E.J., Nelson, W.L., and Fitts, J.W. "The Effect of pH, Sulfate and Phosphate Concentrations on the Adsorption of Sulfate by Soils." <u>Soil Science Society Proceedings</u> 20(1956): 463-466.
- 7. Dixon, J.B., and Week, S.B., eds. Minerals in Soil Environments.

 Wisconsin USA: Soil Science Society of America, Inc., 1977.
- 8. Nyle C. Brady. The Nature and Properties of Soils. 8th.ed. New York:

 Macmillan Publishing Co., 1974.

- 9. Toth, S.J. "Anion Adsorption by Soil Colloids in Relation to
 Changes in Free Iron Oxides." <u>Soil Science</u>

 44 (April 1937): 299-314.
- 10. Pauling, L. "The Structure of Micas and Related Minerals."

 Proceedings of the United States Nation Academy of Sciences
 16(1930): 123-129.
- 11. Marshall, C.E. The Colloid Chemistry of the Silicate Minerals.

 New York: Academic Press, Inc., 1949.
- 12. Farks, G.A. "Aqueous Surface Chemistry of Oxides and Complex Oxide
 Minerals. Isoelectric Point and Zero Point of Charge."

 In R.F. Gould, ed. Advances in Chemistry Series

 67(1967): 121-160.
- 13. Hingston, F.J., Atkinson, R.J., Posner, A.M., and Quirk, J.P.

 "Specific Adsorption of Anions." Nature 215(1967): 1459-1461.
- 14. Mott, C.J.B. "Sorption of Anions by Soils." In Sorption and Transport

 Processes in Soils. Society of Chemical Industry Monograph

 37(1970): 40-53.
- 15. Hingston, F.J., Posner, A.M., and Quirk, J.P. "Anion Binding at Oxide Surfaces the Adsorption Envelope." Search 1(1970): 324-327.
- 16. Breeuwsma, A., and Lyklema, J. "Physical and Chemical Adsorption of Ions in the Electrical Double Layer on Hematite (≪-Fe₂O₃)."

 <u>Journal of Colloid and Interface Science</u> 43(1973) : 437-448.
- 17. Hingston, F.J., Posner, A.M., and Quirk, J.P. "Anion Adsorption by Goethite and Gibbsite. I. The Role of the Proton in Determining Adsorption Envelopes." <u>Journal of Soil Science</u> 23(1972): 177-192.

- 18. Hingston, F.J., Atkinson, R.J., Posner, A.M., and Quirk, J.P. "Specific Adsorption of Anions on Goethite." <u>International Congress of Soil Science</u>, 9th, Adeliade Australia 1(1968a): 669-678.
- 19. Hingston, F.J., Posner, A.M., and Quirk, J.P. "Adsorption of Selenite by Goethite." In R.F. Gould (ed.) Adsorption from Aqueous Solution. Δdvances in Chemistry Series 79(1968b): 82-90.
- 20. Bowden, J.W., Bolland, M.D.A., Posner, A.M., and Quirk, J.P. "General Model for Anion and Cation Adsorption at Oxide Surfaces."

 Nature (London), Physical Science 245(1973): 81-83.
- 21. Schofield, R.K. "The Electrical Charges on Clay Particles."

 Soils and Fertilizers 2(1939): 1-5.
- 22. Chang, M.L., and Thomas, G.W. "A Suggested Mechanism for Sulfate

 Adsorption by Soils." Soil Science Society Proceedings

 27(1963): 281-283.
- 23. Mattson, S. "The Laws of Soil Colloidal Behavior: VI Amphoteric behavior." Soil Science 32(1931): 343-365.
- 24. Toth. S.J. "Iron Oxide Removal from Soil Colloids." <u>Soil Science</u>
 48(1939): 385-401.
- 25. Schofield, R.K, and Samson, H.R. "Flocculation of Kaolinite Due to the Attraction of Oppositely Charged Crystal Faces."
 <u>Discussions of the Faraday Society</u> 18(1954): 135-145.
- 26. Verwey, E.J.W., and Overbeek, J.Th.G. Theory of the Stability of

 Lyophobic Colloids. New York: Elsevier Publ. Co.,

 Inc., 1948.

- 27. Mattson, S. "Anionic and Cationic Adsorption by Soil Colloidal

 Materials of Varying SiO₂/Al₂O₃ + Fe₂O₃ Ratio." <u>Transactions</u>

 International Congress of Soil Science, 1st, Washington

 2(1927): 199-211.
- 28. Overstreet, R., and Dean, L.A. "Availability of Soil Anions." In

 Mineral Nutrition of Plants. E. Truog, ed., University of

 Wisconsin Press, Madison, Wis. 1951:79-105.
- 29. Kunin. R., and Meyers, R.J. "The Anion Exchange Equilibria in an Anion Exchange Resin." Journal of the American Chemical Society 69(1977): 2874-2878.
- 30. Barber, R.G., and Rowell, D.L. "Charge Distribution and the Cation Exchange Capacity of an Iron. Rich Kaolinitic Soil."

 Journal of Soil Science 23(1972): 135-146.
- 31. Beckwith, R.S. "Sorbed Phosphate at Standard Supernatant Concentration as an Estimate of the Phosphate Needs of Soils." Australian

 Journal of Experimental Agriculture and Animal Husbandry

 5(1964): 52-58.
- 32. Juo, A.S.R., and Fox, R.L. "Phosphate Sorption Characteristics of Some Bench-Mark Soils of West Africa." Soil Science

 124(March 1977): 370-376.
- 33. Ozanne, P.G., and Shaw, T.C. "Advantages of the Recently Developed Phosphate Sorption Test over the Older Extractant Methods for Soil Phosphate." Transactions, International Congress of Soil Science, 9th, Adelaide Australia 2(1968): 273-280.

- 34. Wild, A. "Soluble Phosphate in Soil and Uptake by Plants."

 Nature 203(1967): 326-327.
- 35. Fox, R.L., and Kamprath, E.J. "Phosphate Sorption Isotherms for Evaluating the P Requirements of Soils." Soil Science

 Society of America Proceedings 34(1970): 902-907.
- 36. Olsen, S.R., and Watanabe, F.S. "Effective Volume of Soil Around

 Plant Roots Determined from Phosphorus Diffusion." Soil

 Science Society of America Proceedings 30(1966): 598-602.
- 37. Fox, R.L., Nishimoto, R.K., Thompson, J.R., and de la Pena, R.S.

 "Comparative External P Requirements of Plants Growing in

 Tropical Soils." Transactions of the International Congress
 of Soil Science, 10th, Moscow 4(1974): 232-239.
- 38. Jones, J.P., and Benson, J.A. "Phosphate Sorption Isotherms for Fertilizer P needs of Sweet Corn (Zea Mays) Grown on a High Phosphorus Fixing Soil." Communications in Soil Science and Plant Analysis 6(1975): 465-477.
- 39. Fox, R.L., and Kang B.T. "Influence of Phosphorus Fertilizer

 Placement and Fertilization Rate on Maize Nutrition."

 Soil Science (1978).
- 40. Hasen, S.M., Fox, R.L., and Boyd, C.C. "Solubility and Availability of Sorbed Sulfate in Hawaiian Soils." Soil Science Society of America Proceedings 34(1970): 897-901.
- 41. Soil Survey Division, Land Development Department. Characteristics

 of Some Soils in Thailand. In Tour Guide for the

 International Soil Classification Workshop 3-9th September

 1978. Bangkok, Thailand.

- 42. Cloos, P., Leonard, A.J., Moreau, J.P., Herbilion, A., and Fripiat, J.J. "Structural Organization in Amorphous Silico-Aluminas."

 Clays and Clay Minerals 17(1969): 279-287.
- 43. Schofield, R.K., and Samson, H.R. "The Deflocculation of Kaolinite Suspensions and the Accompanying Change Over From Positive to Negative Adsorption." Clay Minerals Bulletin 2(1953): 45-51.
- 44. Quirk, J.P. "Negative and Positive Adsorption of Chloride by Kaolinite." Nature 188(1960): 253.
- 45. Summer, M.E., and Reeve, N.G. "The Effect of Iron Oxide Impurities on the Positive and Negative Adsorption of Chloride by Kaolinites." Journal of Soil Science 17(1966): 274-279.
- 46. Chao, T.T., Harward, M.E., and Fang, S.C. "Iron or Aluminum Coatings in Relation to Sulfate Adsorption Characteristics of Soils."

 Soil Science Society of America Proceedings 28(1964): 632-635.
- 47. Adams, Fred, and Rawajfih, Z. "Basaluminite and Aluminite: A Possible Cause of Sulfate Retention by Acid Soils." Soil Science

 Society of America Journal 41(1977): 686-692.
- 48. Barbier, G., and Chabannes, J. "Retention of the Sulfate Ion in Soils."

 Comptes Rendus 218(1944): 519-521.
- 49. Miller, L.B. "Effect of Anions Upon the Physical, Chemical, and Colloidal Properties of Aluminum Hydroxide." Colloid Symposium Monograph 111(1925): 208-215.
- 50. Parfitt, R.L. "Phosphate Adsorption on an Oxisol." <u>Soil Science</u>

 Society of America Journal 41(1977): 1064-1067.

- 51. Muljadi, D., Posner, A.M., and Quirk, J.P. "The Mechanism of Phosphate

 Adsorption by Kaolinite, Gibbsite and Pseudoboehmite."

 Journal of Soil Science 17(1966): 212-247.
- 52. Atkinson, R.J. "Ton Binding by Ferric Oxide surfaces." Honours Thesis
 University of Western Australia, Nedlands, 1966.
- 53. Nagarajah, S., Posner, A.M., and Quirk, J.P. "Desorption of Phosphate from Kaolinite by Citrate and Bicarbonate." Soil Science

 Society of America Proceedings 32(1968): 507-510.
- 54. Parfitt, R.L., Atkinson, R.J., and Smart, R.St.C. "The Mechanism of Phosphate Fixation on Iron Oxides." Soil Science Society of America Proceedings 39(1975): 837-841.
- 55. Parfitt, R.L., Russell, J.D., and Farmer, V.C. "Confirmation of the Surface Structures of Goethite (X-Fe00H) and Phosphated Goethite." Journal of the Chemical Society, Faraday

 Transactions 72(1976): 1082-1087.
- 56. Atkinson, R.J., Posner, A.M., and Quirk, J.P. "Kinetics of Isotopic Exchange of Phosphate at the X-FeOOH-Aqueous Solution Interface." Journal of Inorganic and Nuclear Chemistry 34(1972): 2201-2211.
- 57. Parfitt, R.L., and Atkinson, R.J. "Adsorption of Phosphate on Goethite." Nature 264(1976): 740-741.

APPENDIX

Preparation of Concentrated Ammonium Molybdate Solution

Twenty five grams of (NH₄)₆Mo₇O₂₄. 4H₂O are dissolved in 200 cm.³ of lukewarm distilled water, 290 cm.³ of concentrated sulphuric acid are diluted to 750 cm.³ with distilled water. After cooling, ammonium molybdate solution is added slowly with stirring to sulphuric acid solution and the volume is made to 1000cm.³ and then stored in a dark glass bottle in a refrigerator.

Preparation of Dilute Ammonium Molybdate Solution

The concentrated ammonium molybdate solution is diluted by adding slowly 300 cm. of distilled water to 200 cm. of that reagent with stirring and stored in a dark glass bottle in a refrigerator. The dilute solution has to be freshly prepared every one or two months.

Preparation of Concentrated Stannous Chloride Solution

Ten grams of stannous chloride are added to 25 cm. of concentrated hydrochloric acid solution and stored in a dark glass bottle in a refrigerator. The solution also has to be freshly prepared every one or two months.

Preparation of Dilute Stannous Chloride Solution

Two cm. of the concentrated stannous chloride solution are added to 266 cm. of distilled water. The solution has to be prepared after 4 hours of storage.

VITA

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