MINERALOGY OF THE DEFERRIFIED CLAY FRACTION IN B HORIZON OF PEDONS OF THE VIIITH INTERNATIONAL SOIL CLASSIFICATION WORKSHOP

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Abstract

A mineralogical study of the deferrified clay fraction in "B horizons" of 22 pedons located in the Brazilian states of Goiás, São Paulo, Minas Gerais, Rio de Janeiro, and the Federal District was carried out. Most of the samples were taken from the Bo2 and Bto2 horizons. Kaolinite, gibbsite, hydroxy-interlayered vermiculite, and mica are the minerals present. Kaolinite and gibbsite are the dominant ones. Pedons with increasing weathering intensity have gibbsite increase and lower Ki ratios; pedons with decreasing weathering intensity have mica and hydroxy-interlayered vermiculite content increase and higher Ki ratios.

Materials and Methods

Mineralogical analyses were done in the clay fraction of some B horizon of 22 pedons collected in the Brazilian states of Goiás, São Paulo, Minas Gerais, Rio de Janeiro, and the Federal District.

Methods for separation of the clay fraction and the value of the SiO_2/Al_2O_3 molecular ratio (Ki) were carried out according to the procedures described in *Manual de Métodos de Análise de Solo* (Empresa Brasileira de Pesquisa Agropecuária [EMBRAPA] 1979), with some modifications.

The pretreatment for mineralogical analyses—removal of free iron oxides, removal of organic matter, saturation of exchange complex, solvation with glycerol solution—were carried out according to the methods described in Jackson (1974) and Soil Conservation Service (1972), with some modifications.

The x-ray techniques for the clay mineralogy were as follows:

1. Oriented specimens on glass slides were prepared using Mg-saturated samples, also glycerol solvated (glycerol solution of 10 percent in ethanol); K-saturated samples were x-rayed at room temperature (25°C) and afterheating treatments of 150°C, 300°C, and 500°C.
2. X-ray diffraction patterns were obtained for each of the treatments using Rigaku x-ray diffraction equipment Geigerflex System/D max IIA, with the following operating conditions: radiation: Cu Kα; potential: 35 KV; current: 15 mA; goniometric scan speed: 2°(2 θ) per minute; strip-chart drive speed: 10mm/min; time-constant: ls; counting rate: 1000 cps.

The estimate of the amount of mineral present in the sample was evaluated by relative intensities of x-ray diffraction peaks.

Results and Discussion

Data for the clay minerals obtained by XRD in oriented deferrified clay fractions of some B horizon, the estimate of the amount of clay minerals through relative intensities of XRD peaks, and the value of SiO_2/Al_2O_3 molecular ratio (Ki) are shown in Table 1.

Kaolinite with x-ray diffraction peaks in the region of 7.19 Å and gibbsite with the strongest peak of 4.84 Å are the dominant minerals (Figs.1 to 27).

The mineral with basal diffraction peaks in the 14-15 Å region did not expand with Mg saturation and glycerol solvation, and did not collapse on K saturation; subsequent heating at 150°C, 300°C, and 500°C of K-saturated clays resulted in a hydroxy-interlayered vermiculite (HIV). Mica with diffraction peaks in the region of 10 Å is also present.

Taking into consideration the data in Table 1, we see that 7 percent of the horizons studied are dominantly gibbsitic and have low Ki ratios, pedons 11 and 12; about 15 percent of the horizons are dominantly kaolinitic and have high Ki ratios, pedons 2, 22, and 23; about 44 percent of the horizons have dominant kaolinite and small amounts of gibbsite, pedons 1, 3, 4, 5, 6, 10, 13, 15, and 18; 26 percent have dominant kaolinite and large amounts of gibbsite, pedons 7, 8, 9, 14, 16, and 17; and the remaining 7 percent have almost the same amount of gibbsite and kaolinite, pedons 19 and 20.

Hydroxy-interlayered vermiculite is observed in approximately 52 percent of the horizons examined. It is absent or seems to be present in lesser amounts in the horizons with lower Ki ratios. Mica is observed in 30 percent of the horizons, pedons 5, 6, 13, 15, and 16, the ones with the highest Ki ratio.

The movement of Si controls the weathering and the

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Table 1. Summary Data of Dominant Mineralogy of Deferrified Clay and Values of SiO_2/Al_2O_3 Molecular Ratio (Ki) in B horizon of 22 Pedons

			Mineralogy of the Clay Fraction				
ISCW Pedon	Horizon	Depth (cm)	Minerals K	G	HIV	Mi	Ki
1	Bo2	-160	xxx	x	x		1.41
2	Bo1	-280	xxx	tr			1.68
3	Bo1	-180	xxx	x	x		1.48
4	Bo2	-255	xxx	x	x		1.50
5	Bto2	-78	xxx	x	x	tr	1.62
5	Bo2	-290	xxx	x	x	tr	1.67
6	Bto2	-60	xxx	x	x	x	1.84
6	Bo2	-225	xxx	x	x	x	1.75
7	Bo2	-280	xxx	xx			0.85
8	Bo2	-235	xxx	xx	tr		1.11
9	Bo1	-225	xxx	xx			0.54
10	Bo2	-240	xxx	x			0.75
11	Bo3	-239	xx	xxx			0.34
12	Bov3	-150	x	xxx			0.44
13	Bo2	-210	xxx	x	x	x	2.01
14	Bo2	-210	xxx	xx	tr		1.17
15	Bto1	-70	xxx	x		x	1.31
16	Bto1	-60	xxx	xx		x	1.09
16	Bo	-177	xxx	xx		x	0.97
17	Bo3	-200	xxx	xx	tr		0.61
18	Bo	-156	xxx	x			0.65
18	Boc2	-290	xxx	x			0.88
19	Boc1	-175	≈	≈			0.39
20	Bo2	-165	≈	≈			0.65
22	Bo1	-150	xxx	tr	x		1.65
23	Bog1	-70	xxx	tr	x		1.79
23	Bcvg	-180	xxx	tr	x		1.77

Note: Estimate of the amount of minerals: xxx = dominant, xx = large amount; x = small amount; tr = trace; ≈ approximately same amount of K and G; Ki = Si_2/Al_2O_3 molecular ratio from H_2SO_4 and NaOH digestion in clay fraction (< 0.002 mm); HIV = hydroxy-interlayered vermiculite; K = kaolinite; G = gibbsite; Mi = mica.

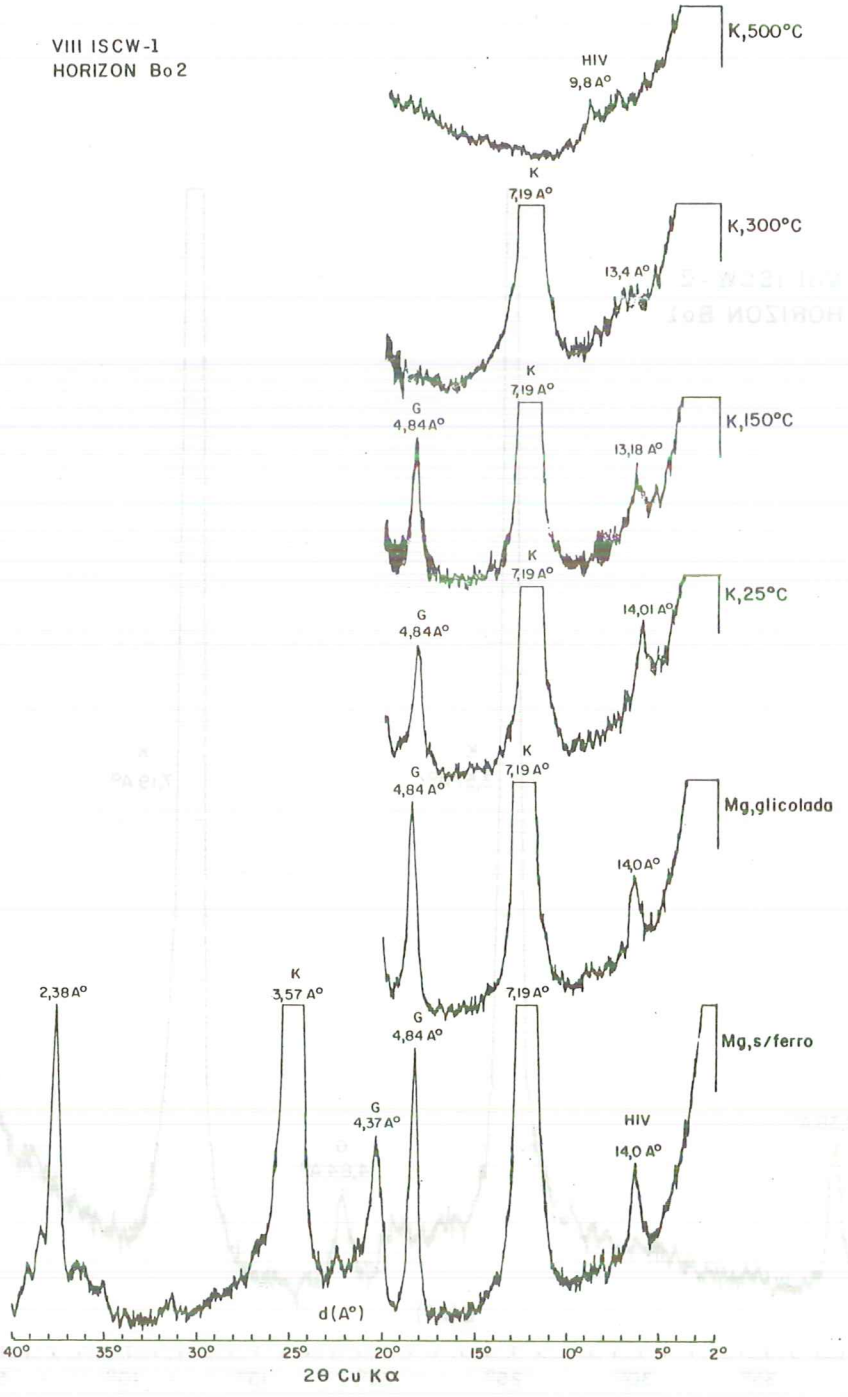

Fig. 1. X-ray diffraction patterns of the deferrified clay from Bo2 horizon of pedon 1 after Mg saturation and glycerol solvation, K saturation at room temperature (K 25° C), heating at 150° C, 300° C, and 500° C. Units of d spacing are in angstrom Å. Hydroxy-interlayered vermiculite (HIV); gibbsite (G); kaolinite (K).

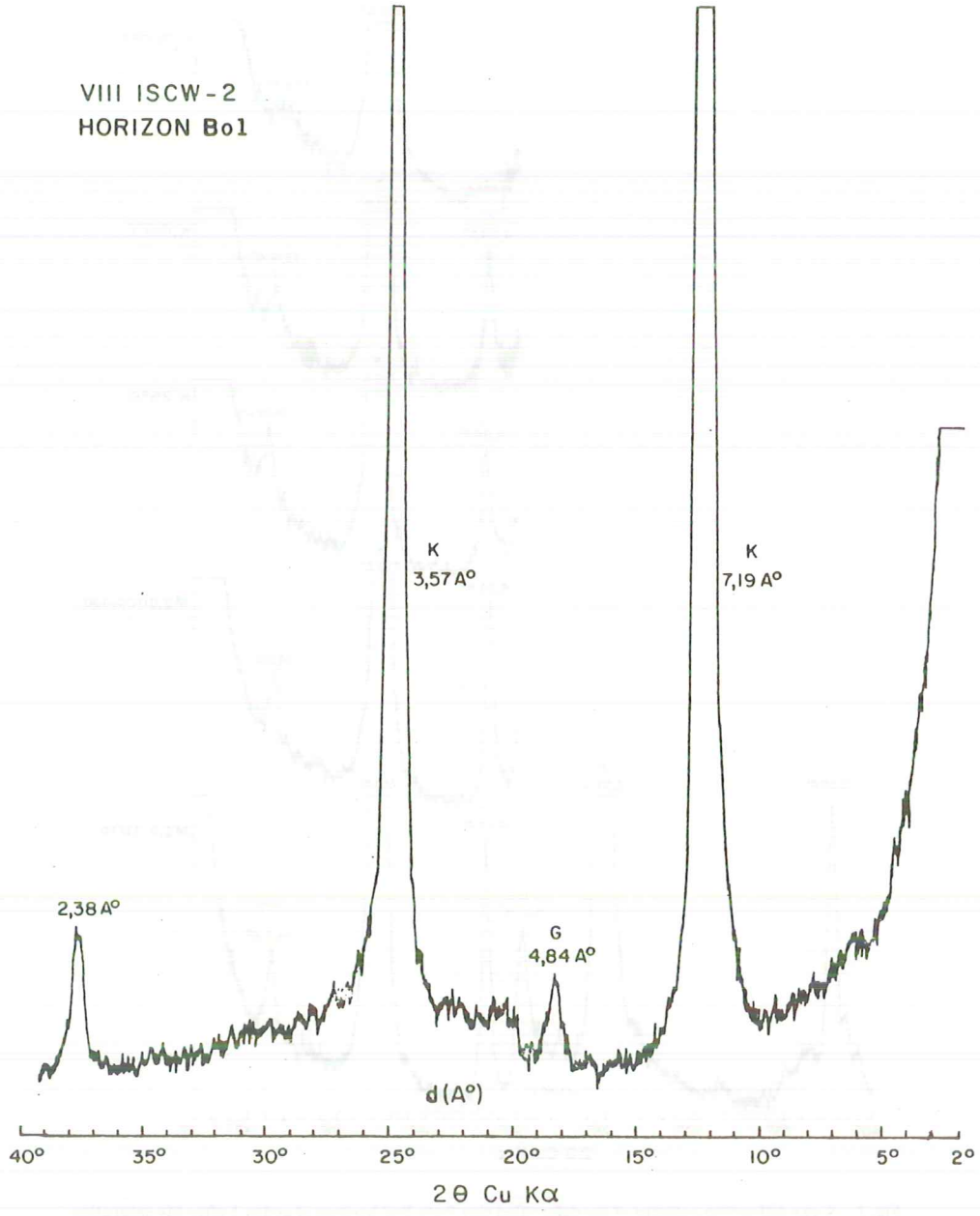

Fig. 2. X-ray diffracton patterns of the deferrified clay from Bo1 horizon of pedon 2. Units of d spacing are in angstrom Å. Kaolinite (K); gibbsite (G).

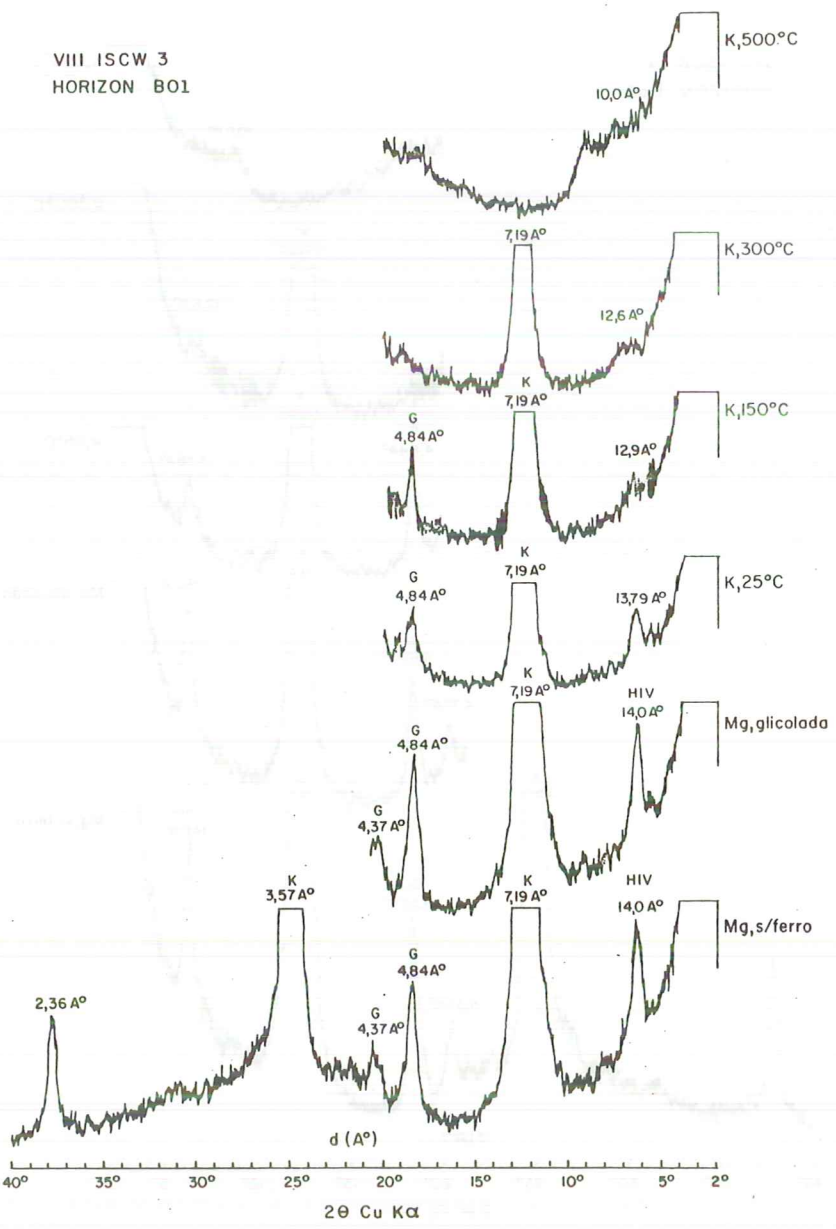

Fig. 3. X-ray diffraction patterns of the deferrifed clay from Boi horizon of pedon 3 after Mg saturation and glycerol solvation, K saturation at room temperature (K 25°C), heating at 150°C, 300°C and 500°C. Units of d spacing are in angstrom Å. Hydroxy-interlayered vermiculite (HIV); gibbsite (G); kaolinite (K).

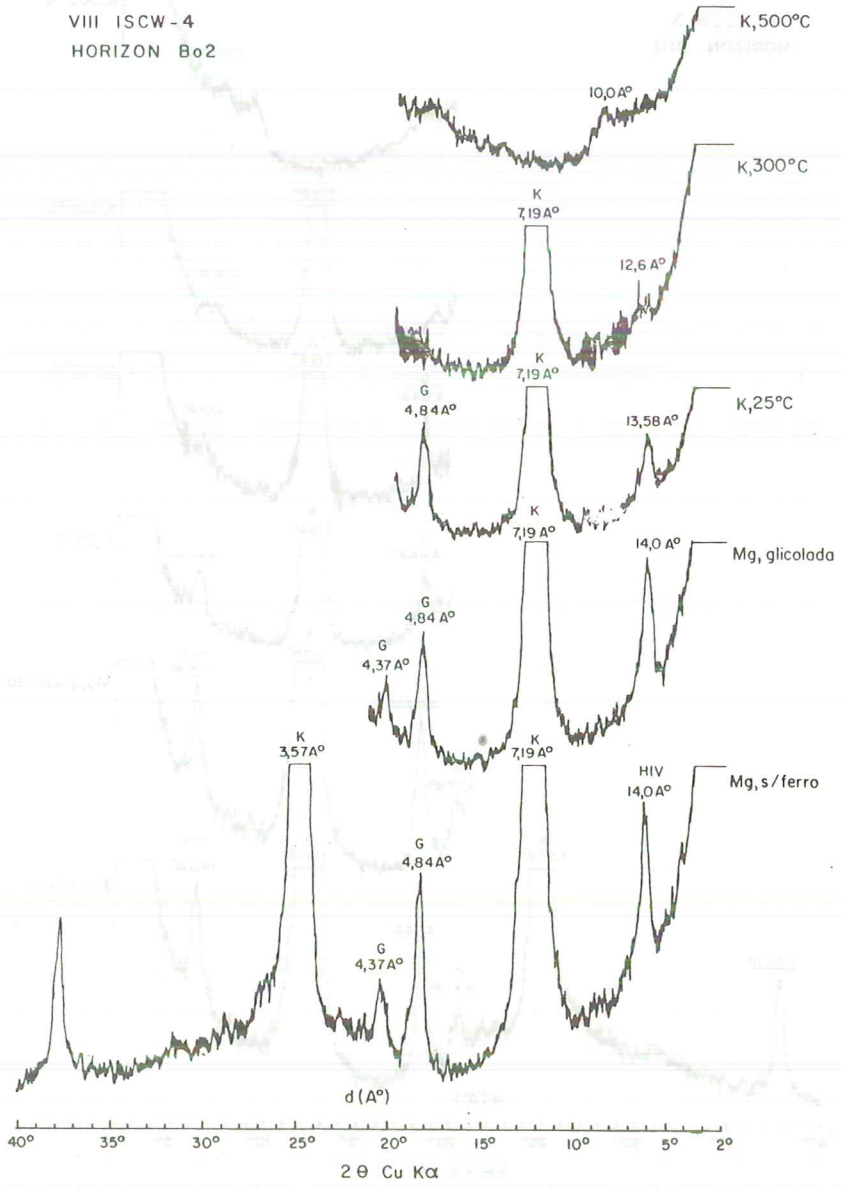

Fig. 4. X-ray diffraction patterns of the deferrified clay from Bo2 horizon of pedon 4 after Mg saturation and glycerol solvation, K saturation at room temperature (K 25°C), heating at 300°C and 500°C. Units of d spacing are in angstrom Å. Hydroxy-interlayered vermiculite (HIV); gibbsite (G); kaolinite (K).

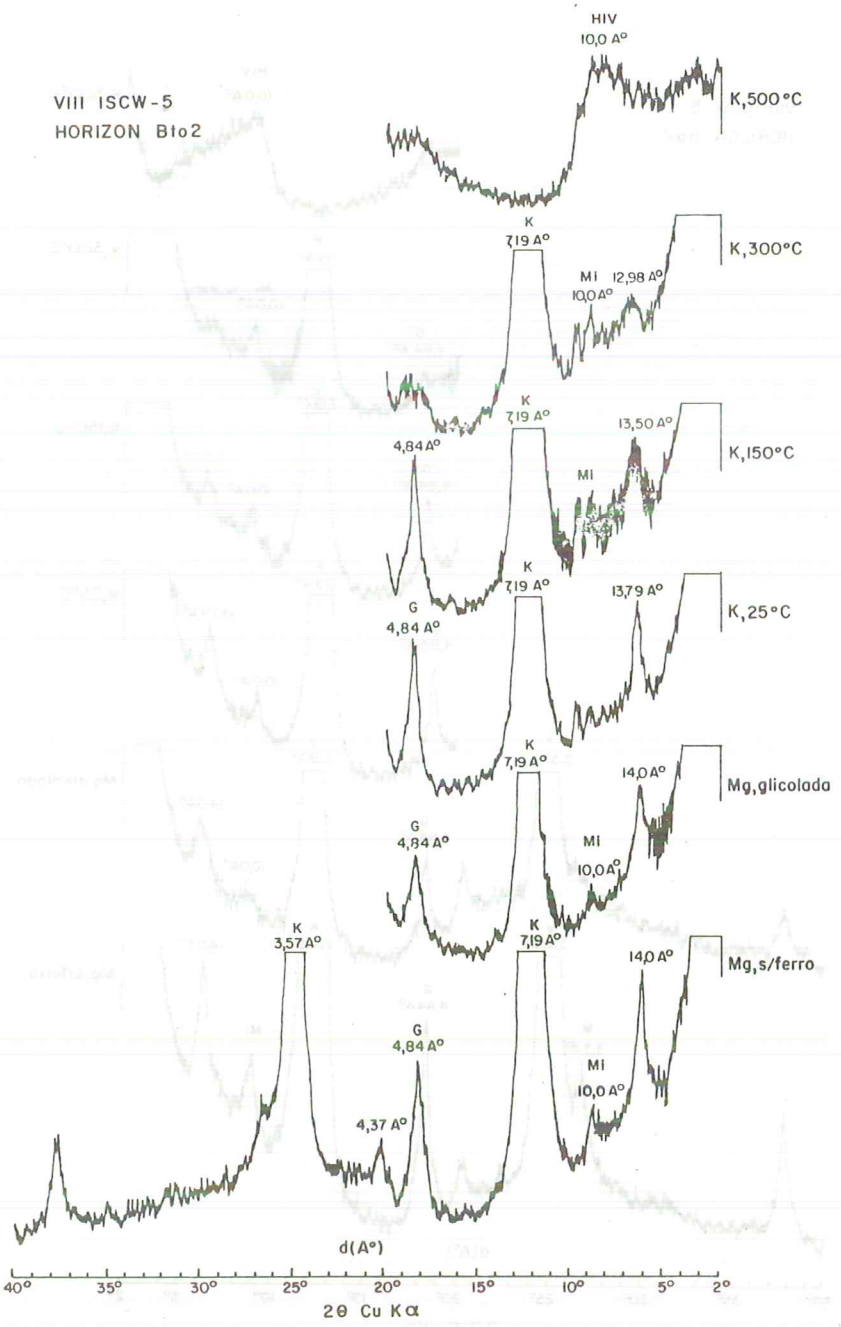

Fig. 5. X-ray diffraction patterns of the deferrified clay from Bto2 horizon of pedon 5 after Mg saturation and glycerol solvation, K saturation at room temperature (K 25°C), heating at 150°C, 300°C, and 500°C. Units of d spacing are in angstrom Å. Kaolinite (K); gibbsite (G); hydroxy-interlayered vermiculite (HIV).

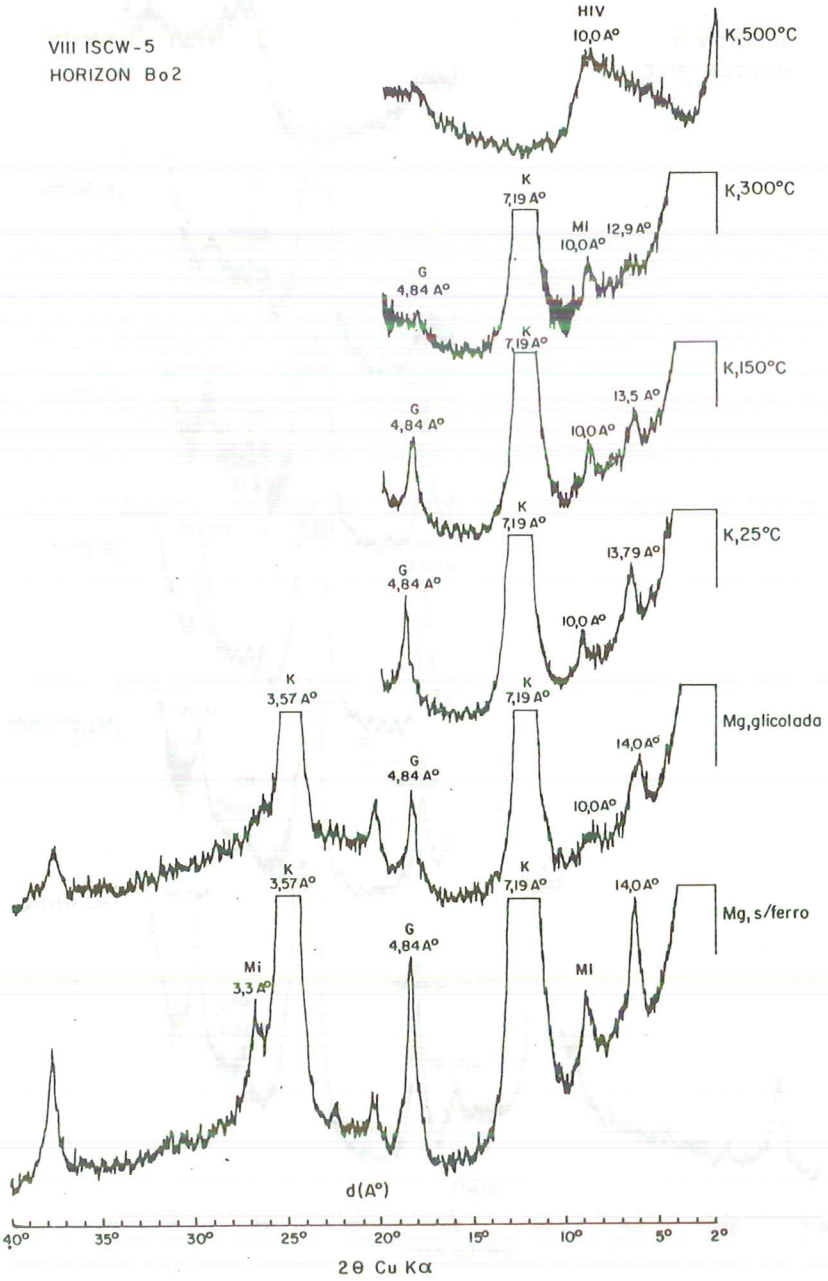

Fig. 6. X-ray diffraction patterns of the deferrified clay from Bo2 horizon of pedon 5 after Mg saturation and glycerol solvation, K saturation at room temperature (K 25°C), heating at 150°C, 300°C, and 500°C. Units of d spacing are in angstrom Å. Kaolinite (K); gibbsite (G); hydroxy-interlayered

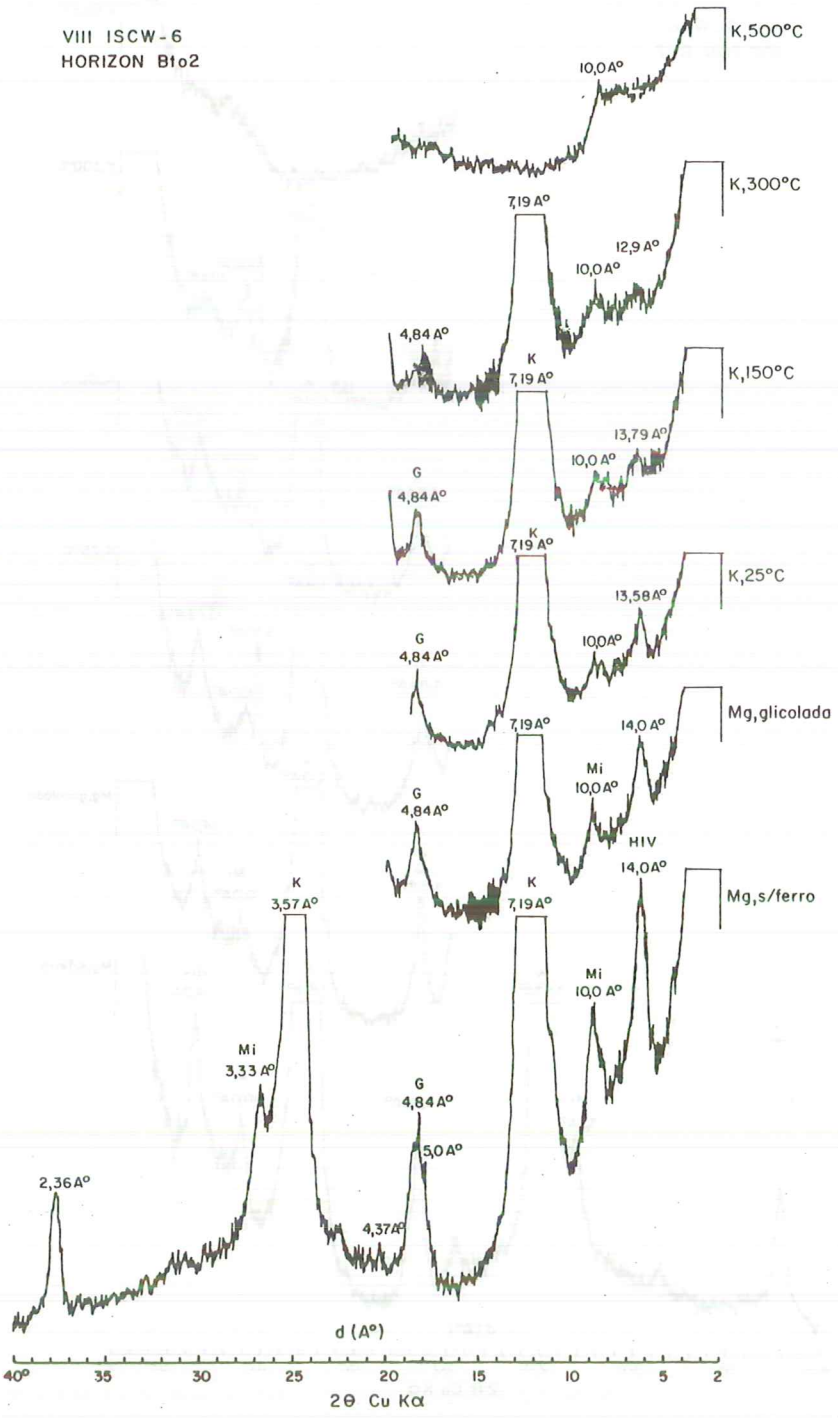

Fig. 7. X-ray diffraction patterns of the deferrified clay from Bto2 horizon of pedon 6 after Mg saturation and glycerol slovation, K saturation at room temperature (K 25°C), heating at 150°C, 300°C, and 500°C. Units of d spacing are in angstrom Å. Kaolinite (K); gibbsite (G); hydroxy-interlayered vermiculite (HIV).

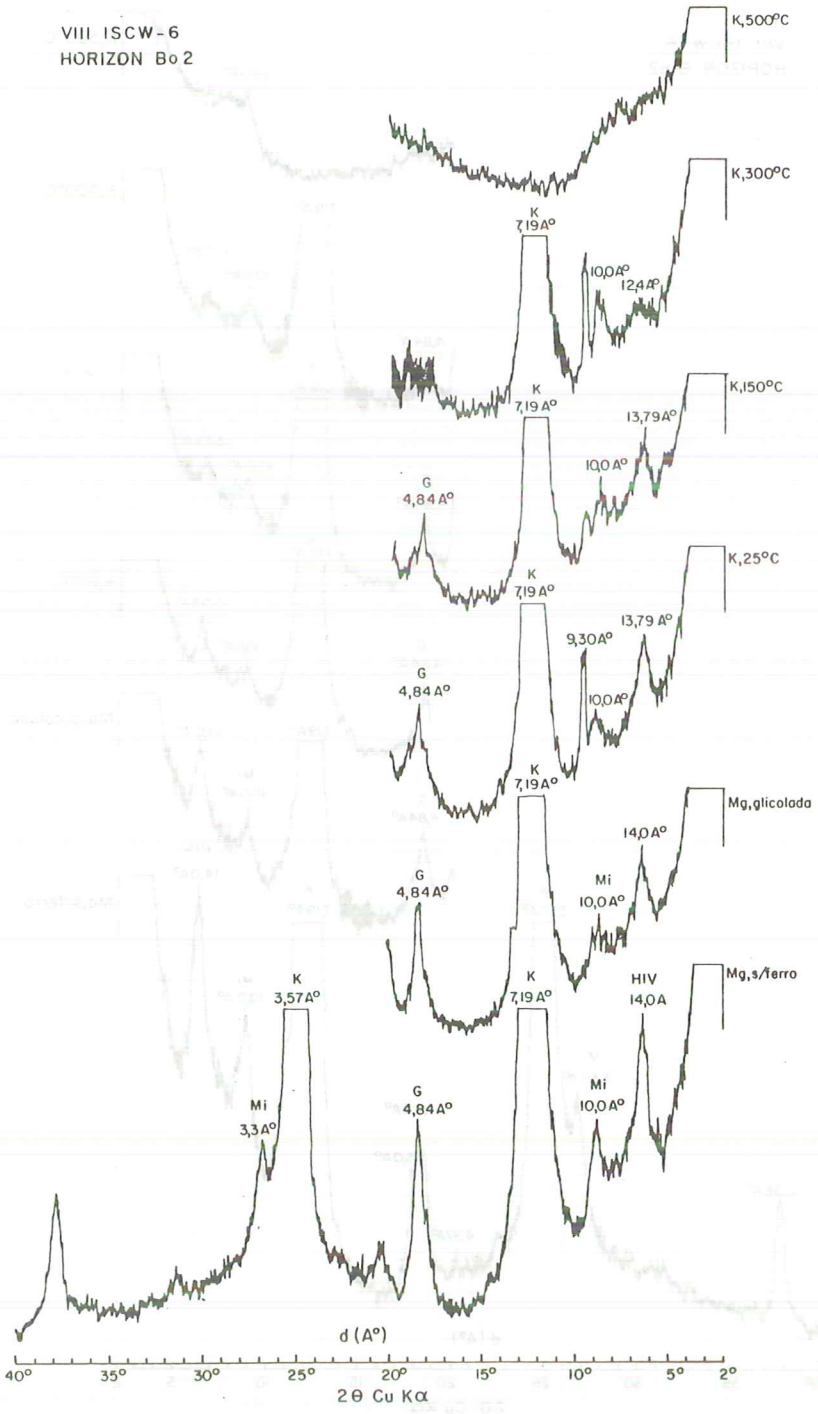

Fig. 8. X-ray diffraction patterns of the deferrified clay from Bo2 horizons of pedon 6 after Mg saturation and glycerol solvation; K saturation at room temperature (K 25°C), heating at 150°C, 300°C, and 500°C. Units of d spacing are in angstrom Å. Hydroxy-interlayered vermiculite (HIV); kaolinite (K); gibbsite(G).

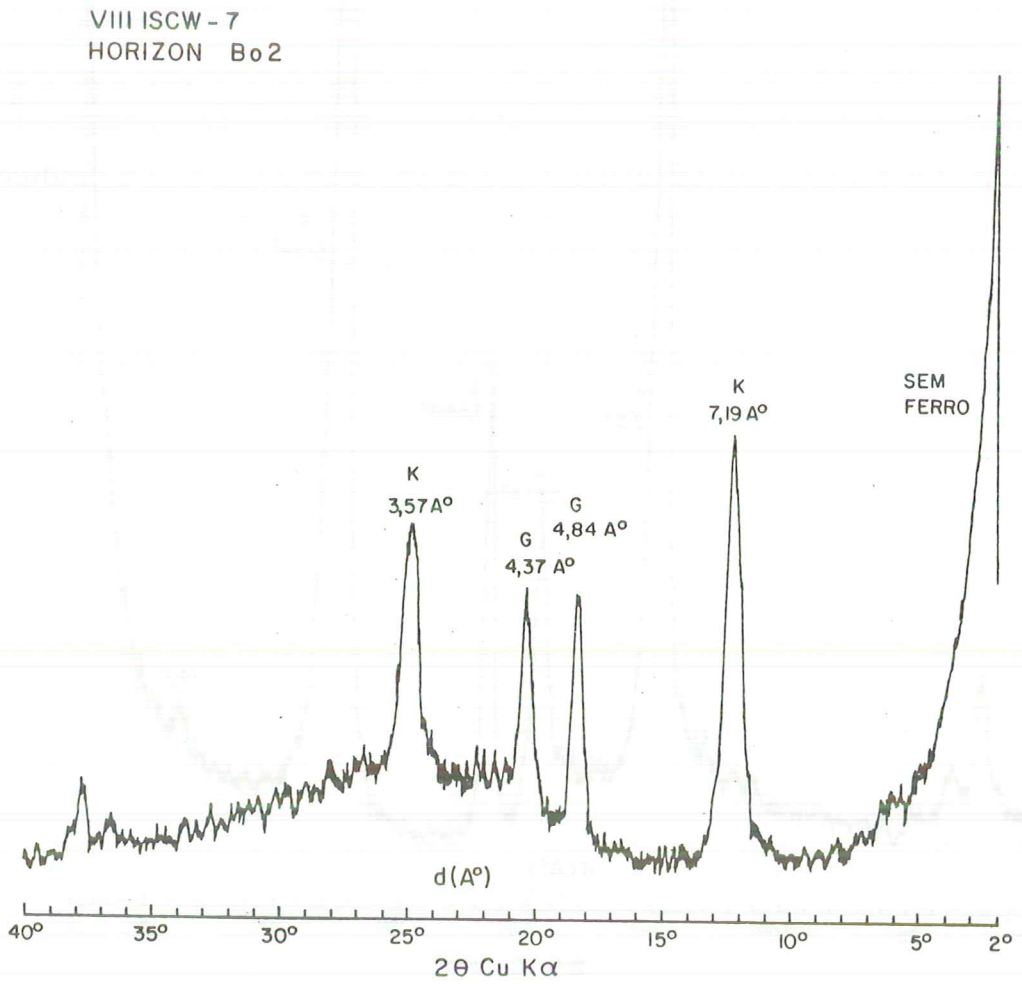

Fig. 9. X-ray diffraction patterns of the deferrified clay from Bo2 horizon of pedon 7. Units of d spacing are in angstrom Å. Kaolinite (K); gibbsite (G).

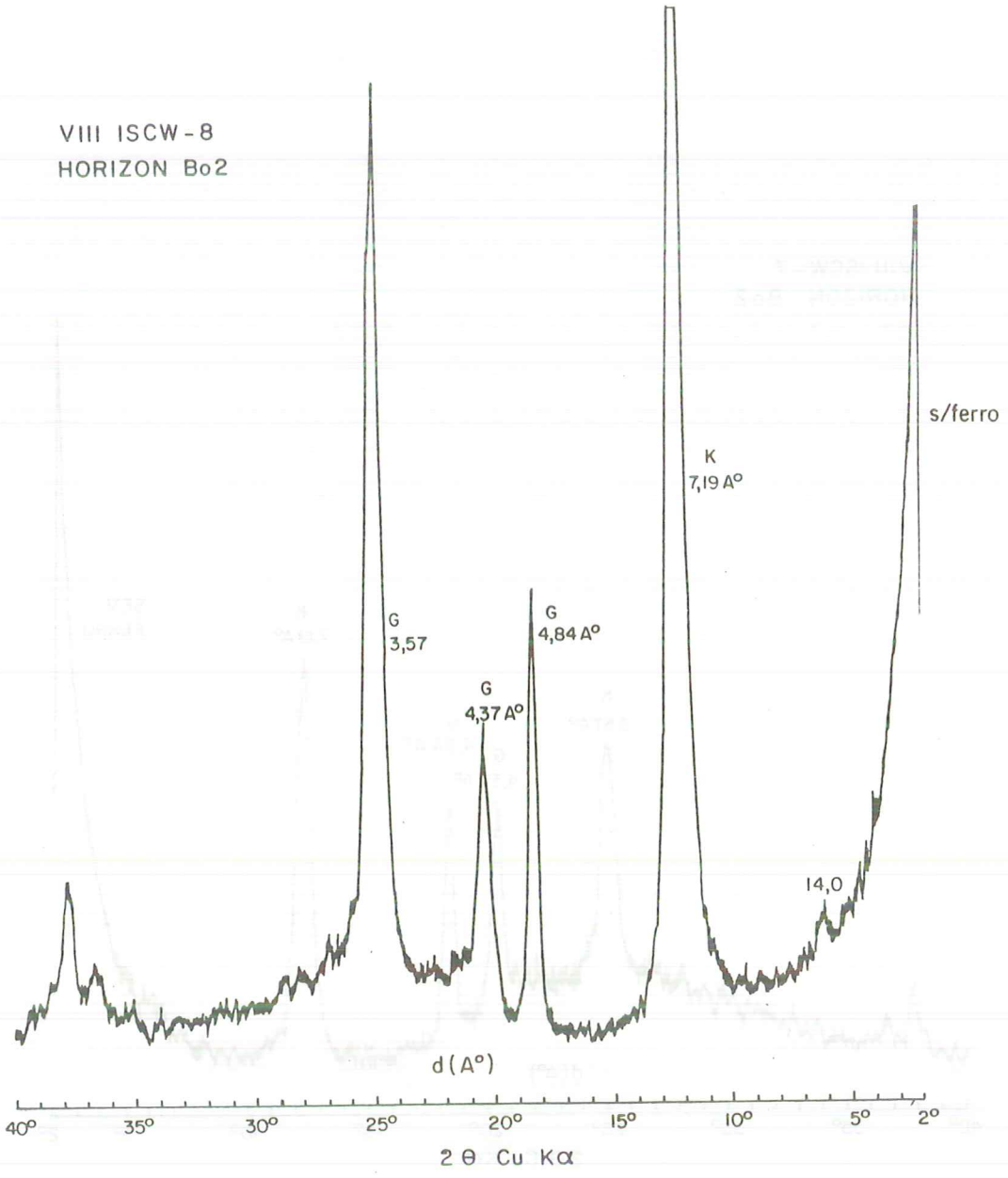

Fig. 10. X-ray diffraction patterns of the deferrified clay from Bo2 horizon of pedon 8. Units of d spacing are in angstrom Å. Kaolinite (K); gibbsite (G).

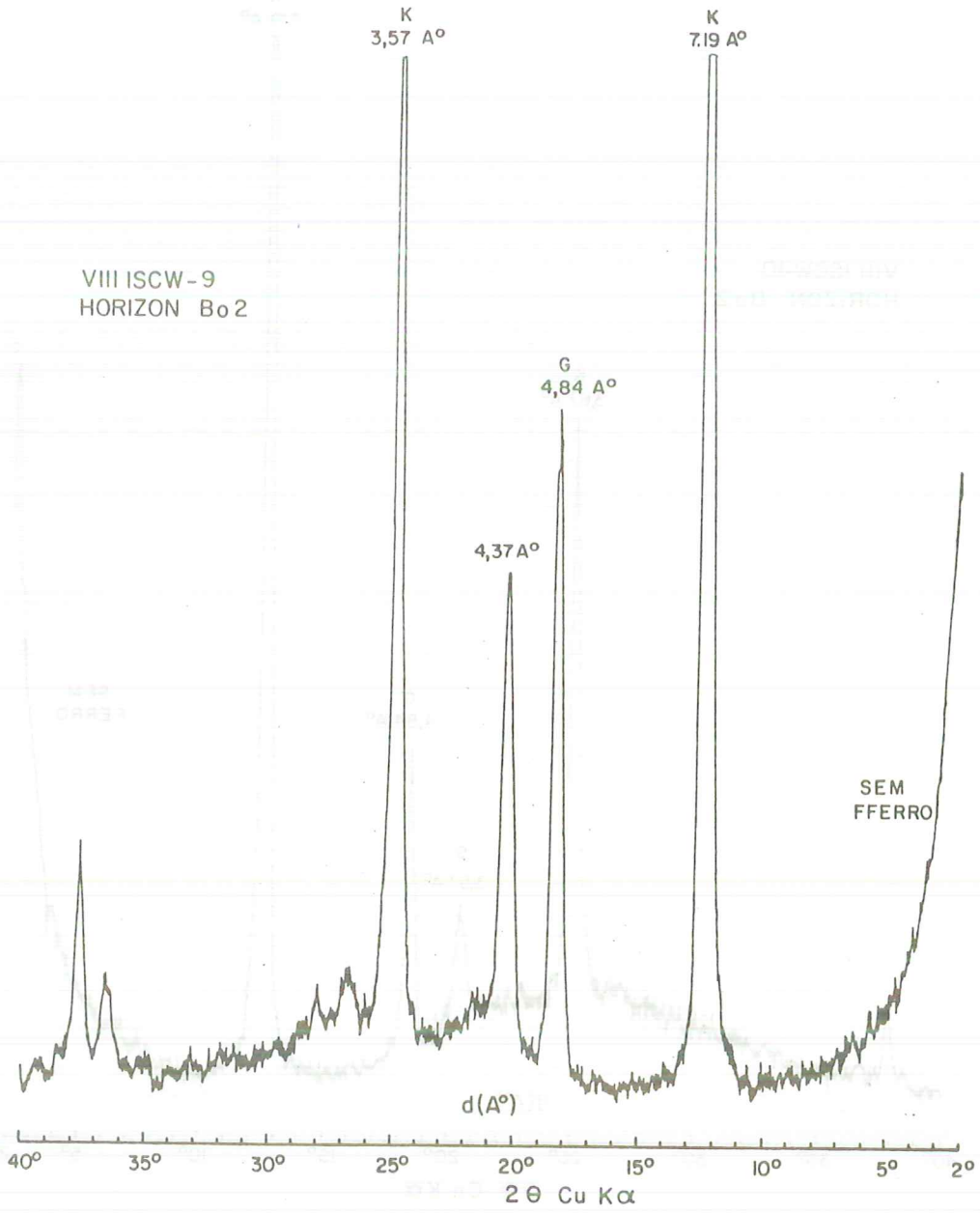

Fig. 11. X-ray diffraction patterns of the deferrified clay from Bo2 horizon of pedon 9. Units of d spacing are in angstrom Å. Kaolinite (K); gibbsite (G).

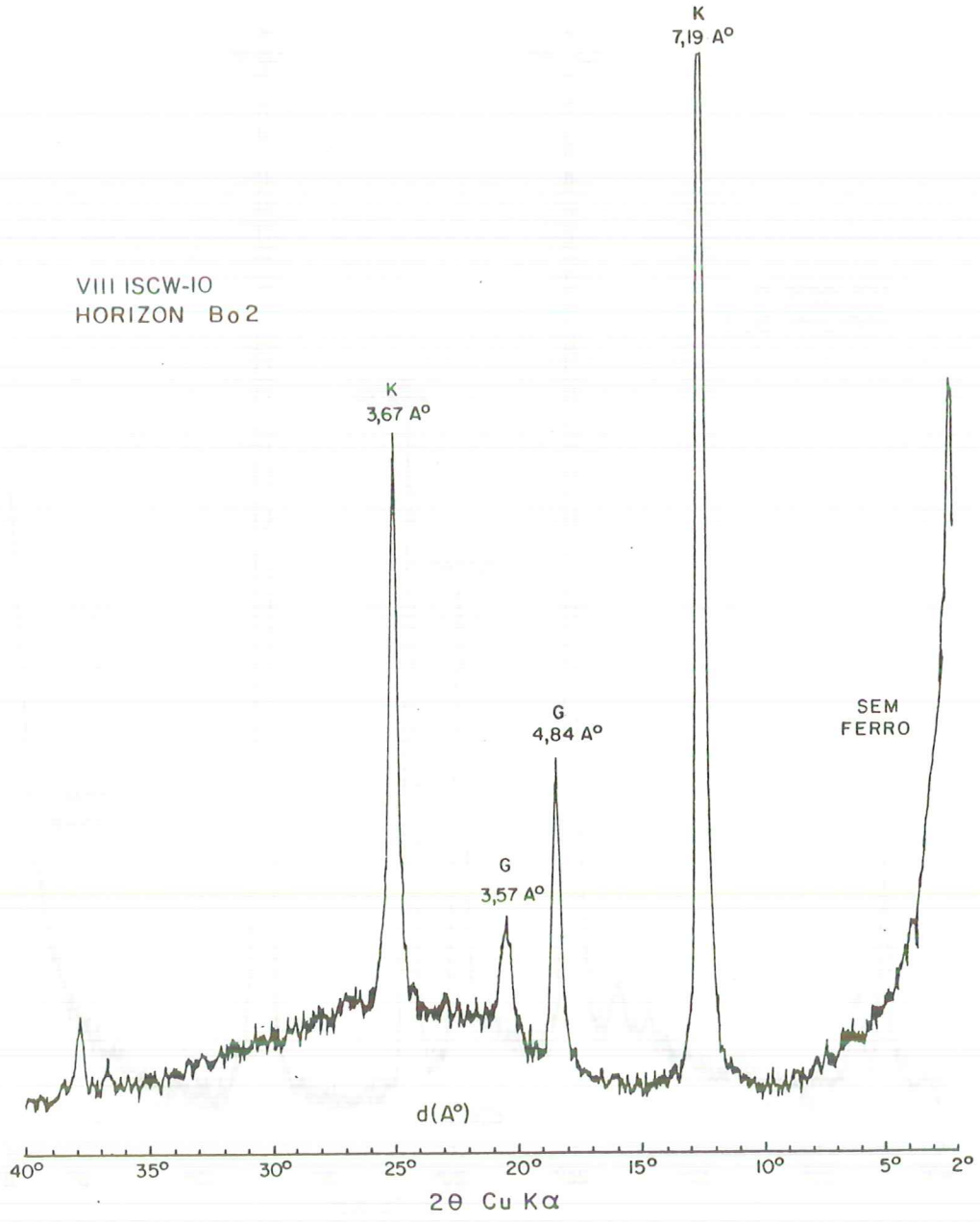

Fig. 12. X-ray diffraction patterns of deferrified clay from Bo2 horizon of pedon 10. Units of d spacing are in angstrom Å. Kaolinite (K); gibbsite (G).

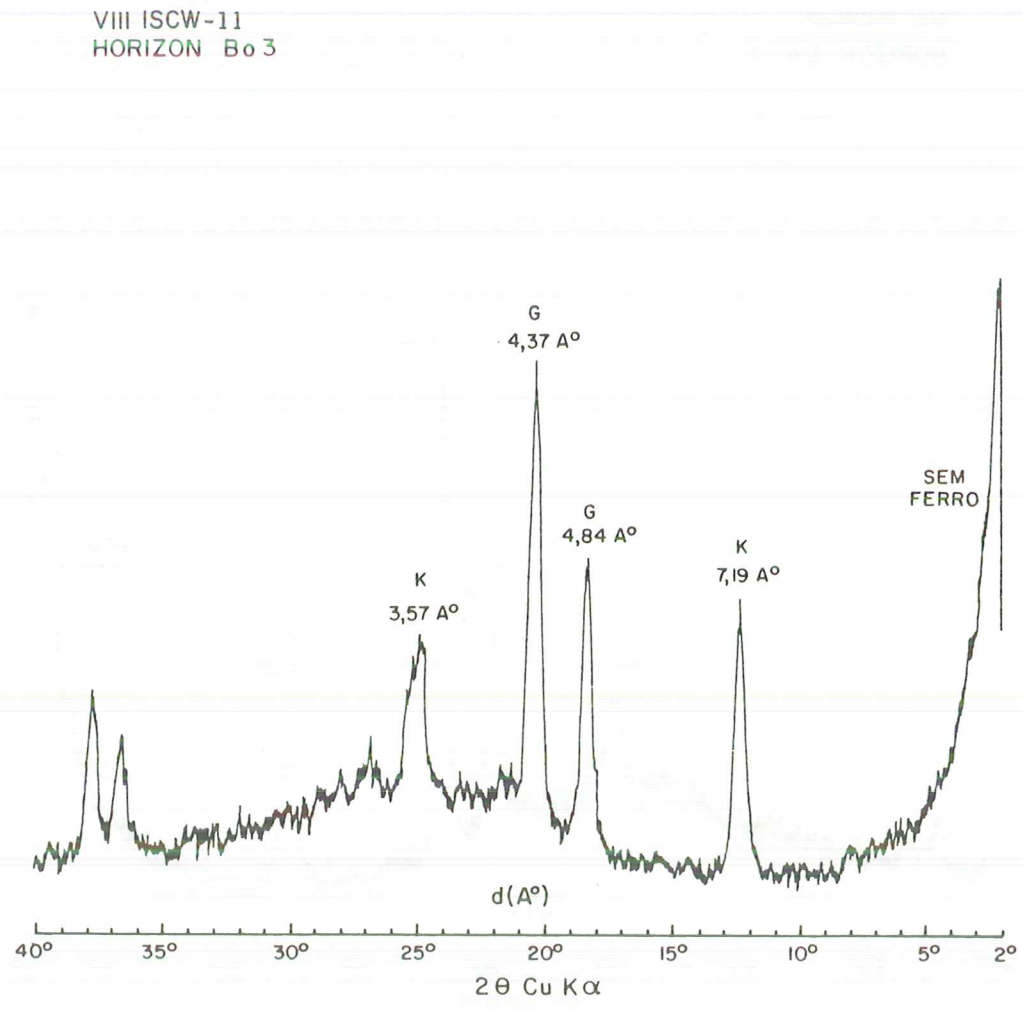

Fig. 13. X-ray diffrection patterns of the deferrified clay from Bo3 horizon of pedon 11. Units of d spacing are in angstrom Å. Kaolinite (K); gibbsite (G).

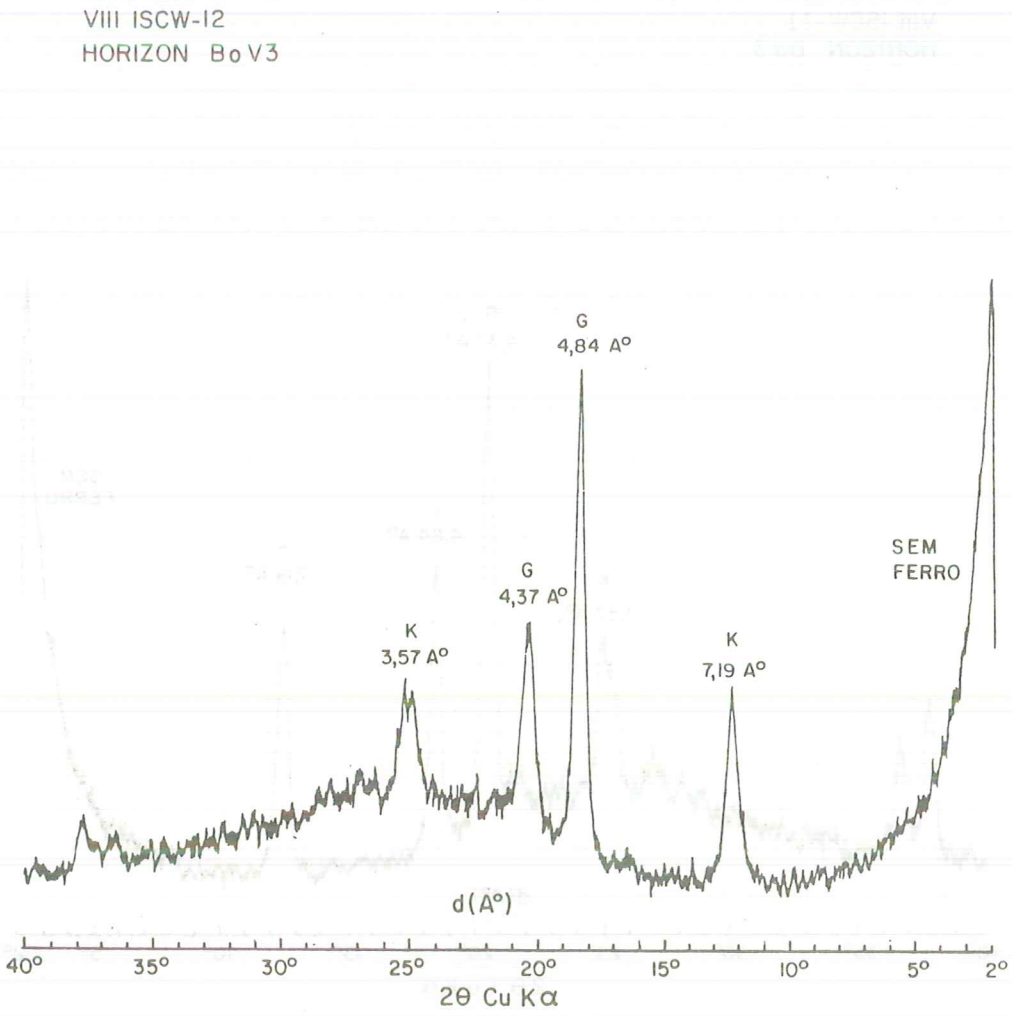

Fig. 14. X-ray diffraction patterns of the deferrified clay from Bov3 horizon of pedon 12. Units of d spacing are in angstrom Å. Kaolinite (K); gibbsite (G).

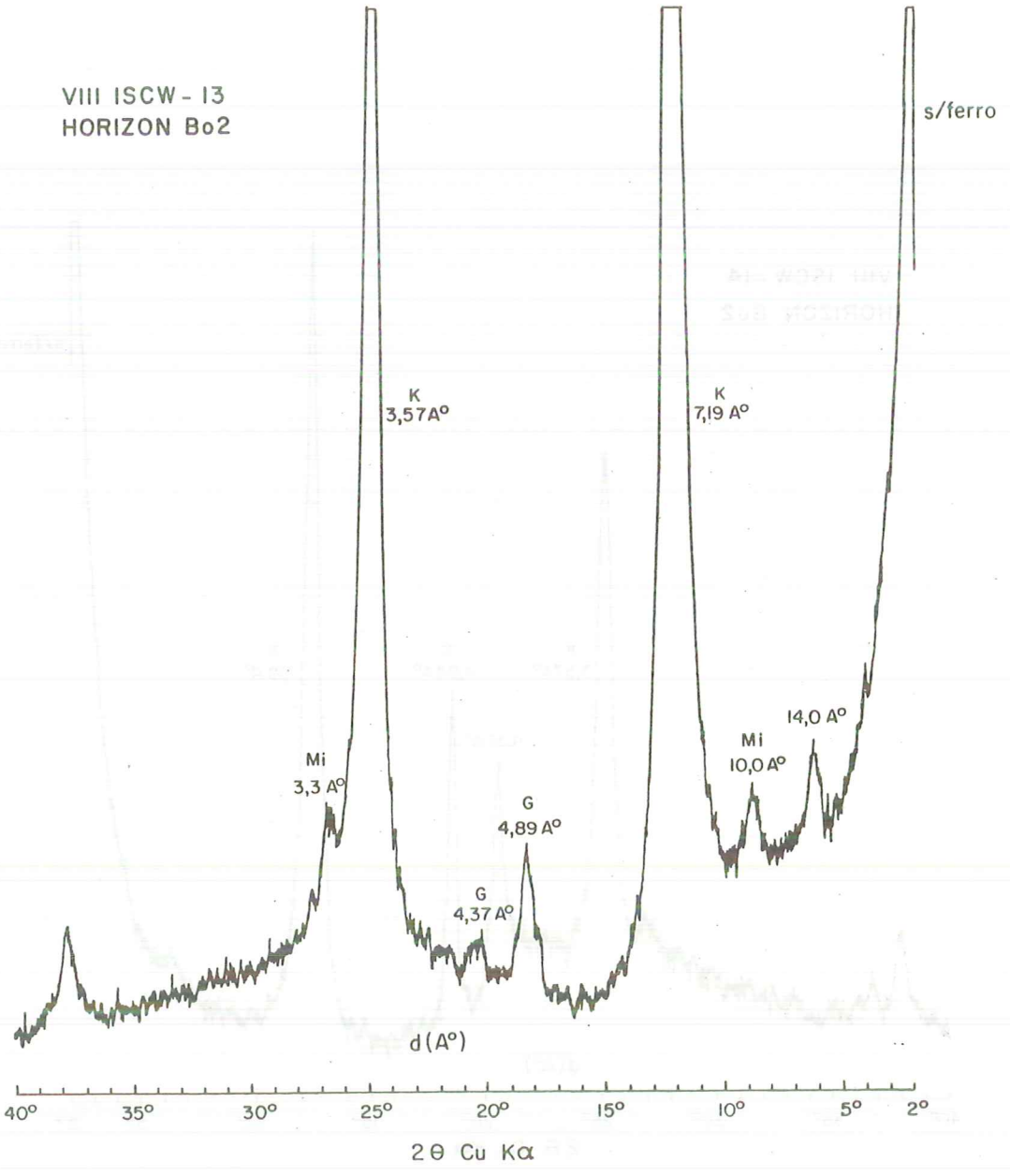

Fig. 15. X-ray diffraction patterns of the deferrified clay from Bo2 horizon of pedon 13. Units of d spacing are in angstrom Å. Kaolinite (K); gibbsite (G); mica (Mi); hydroxy-interlayered vermiculite (HIV).

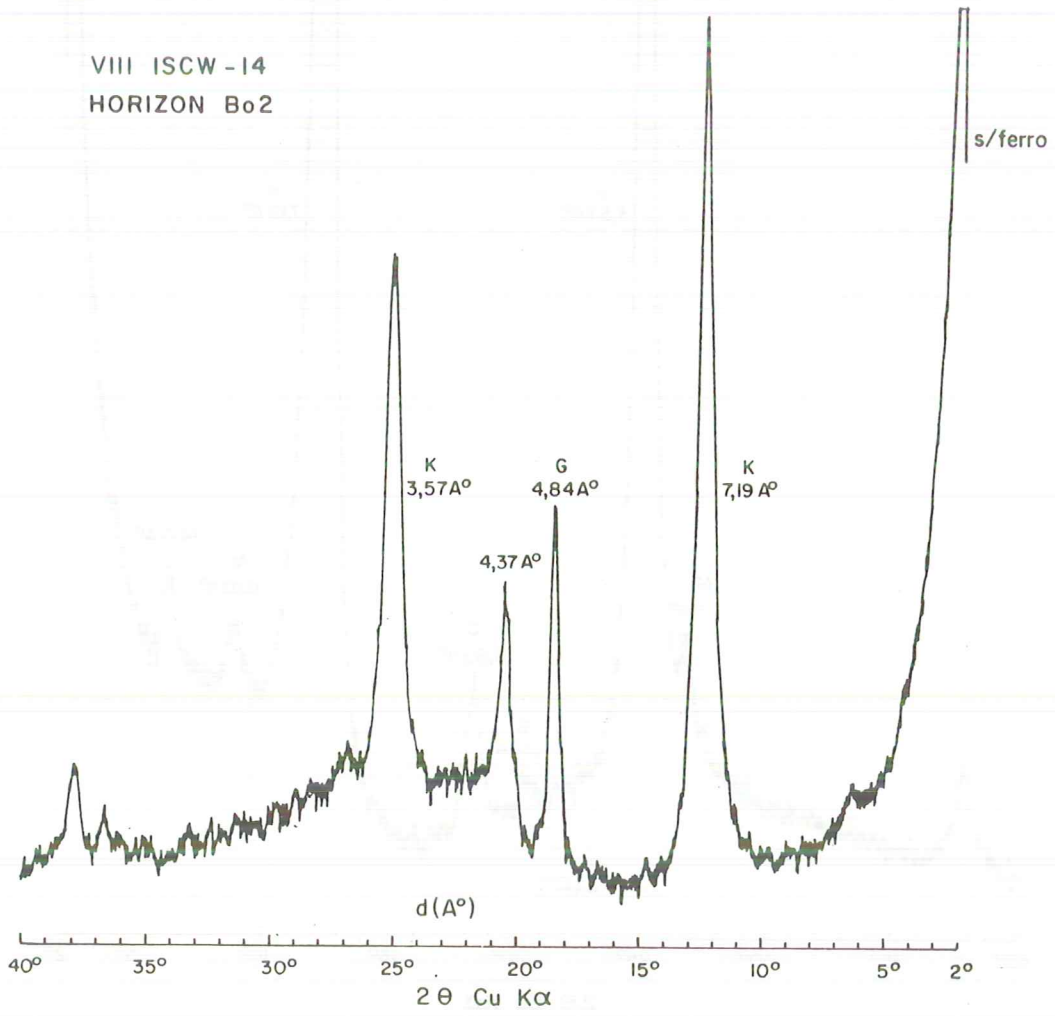

Fig. 16. X-ray diffraction pattern of the deferrified clay from Bo2 horizon of pedon 14. Units of d spacing are in angstrom Å. Kaolinite (K); gibbsite (G).

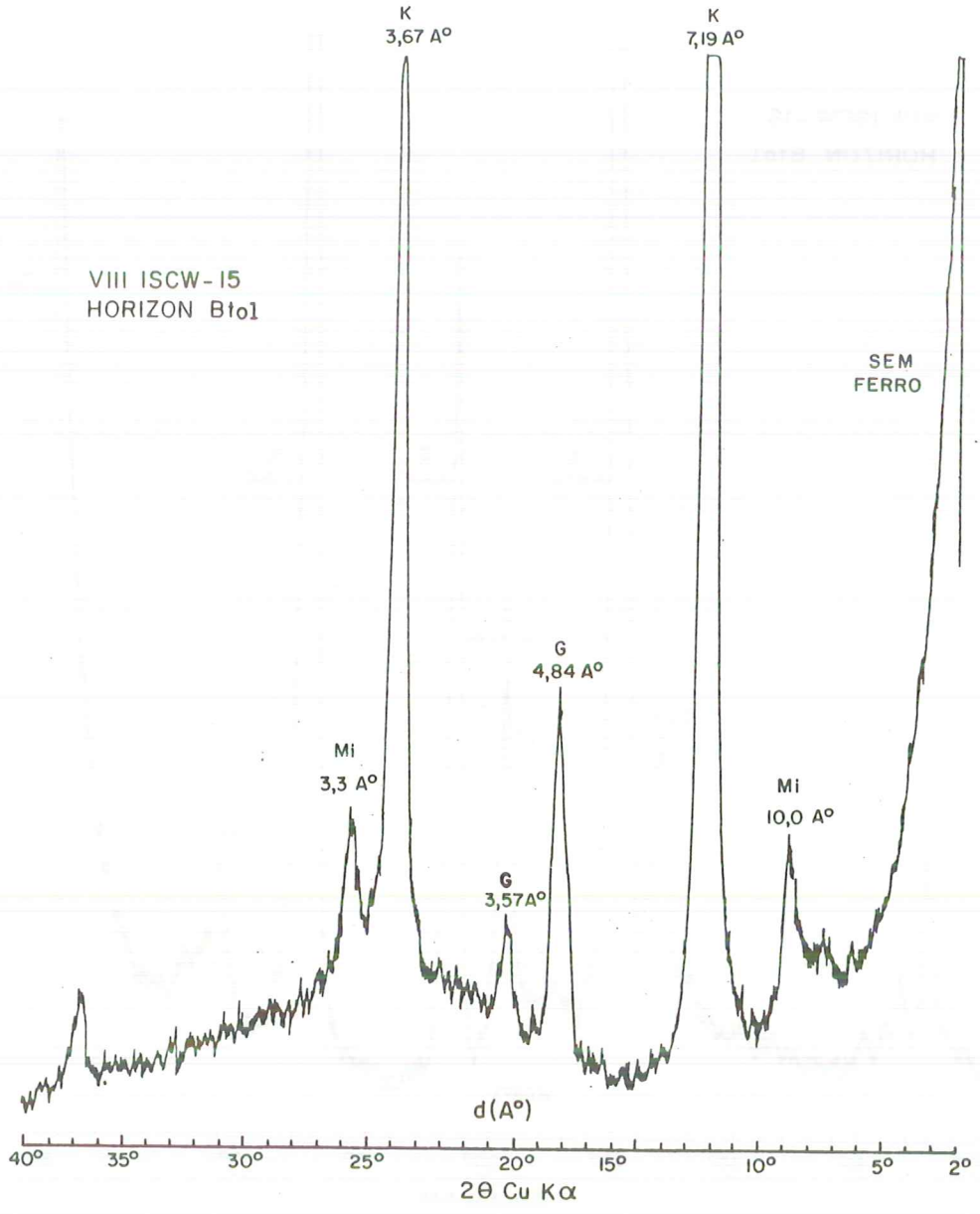

Fig. 17. X-ray diffraction patterns of the deferrified clay from Bto1 horizon of pedon 15. Units of d spacing are in angstrom Å. Kaolinite (K); gibbsite (G); mica (Mi).

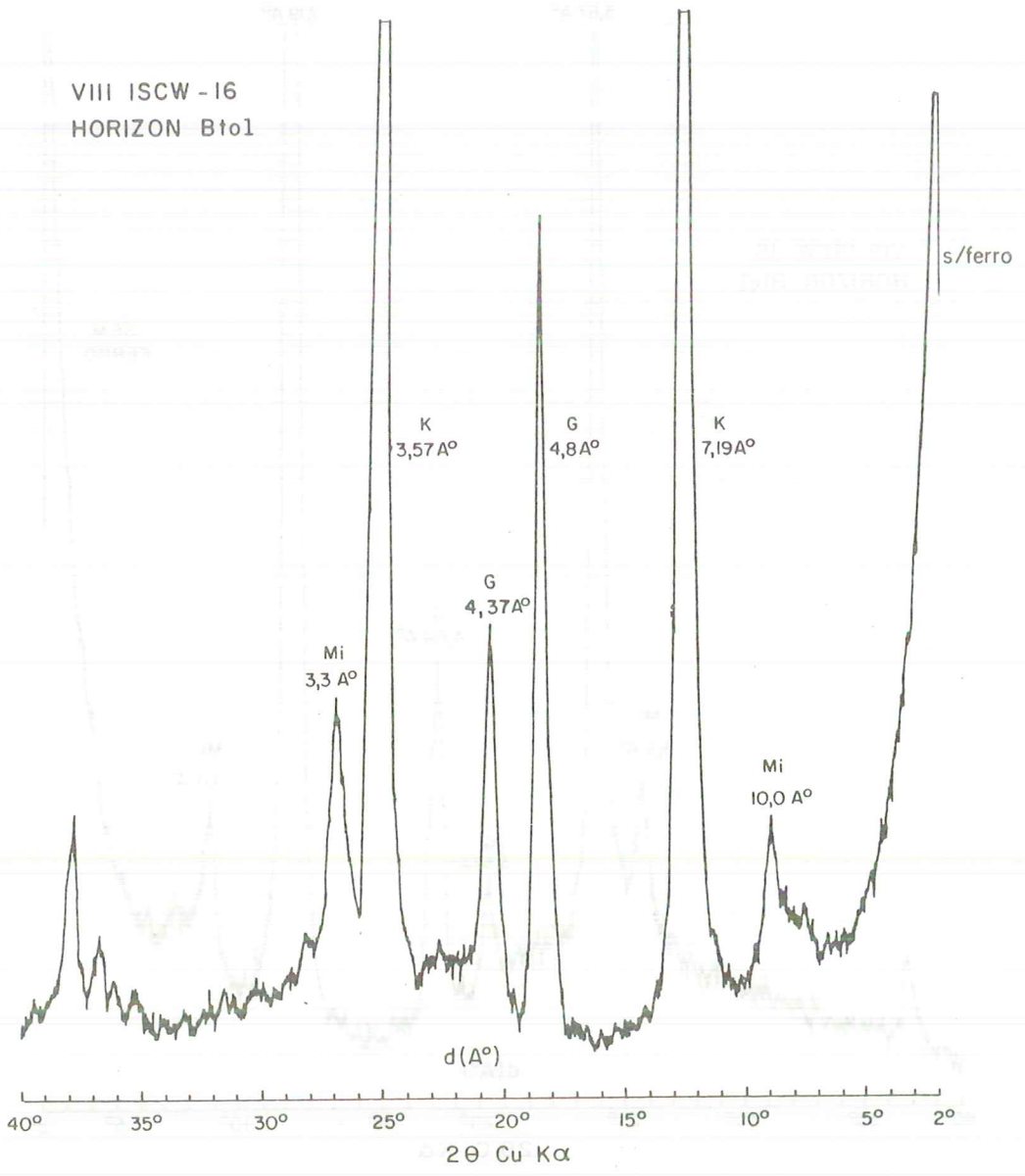

Fig. 18. X-ray diffraction patterns of the deferrified clay from Bto1 horizon of pedon 16. Units of d spacing are in angstrom Å. Kaolinite (K); gibbsite (G); mica (Mi).

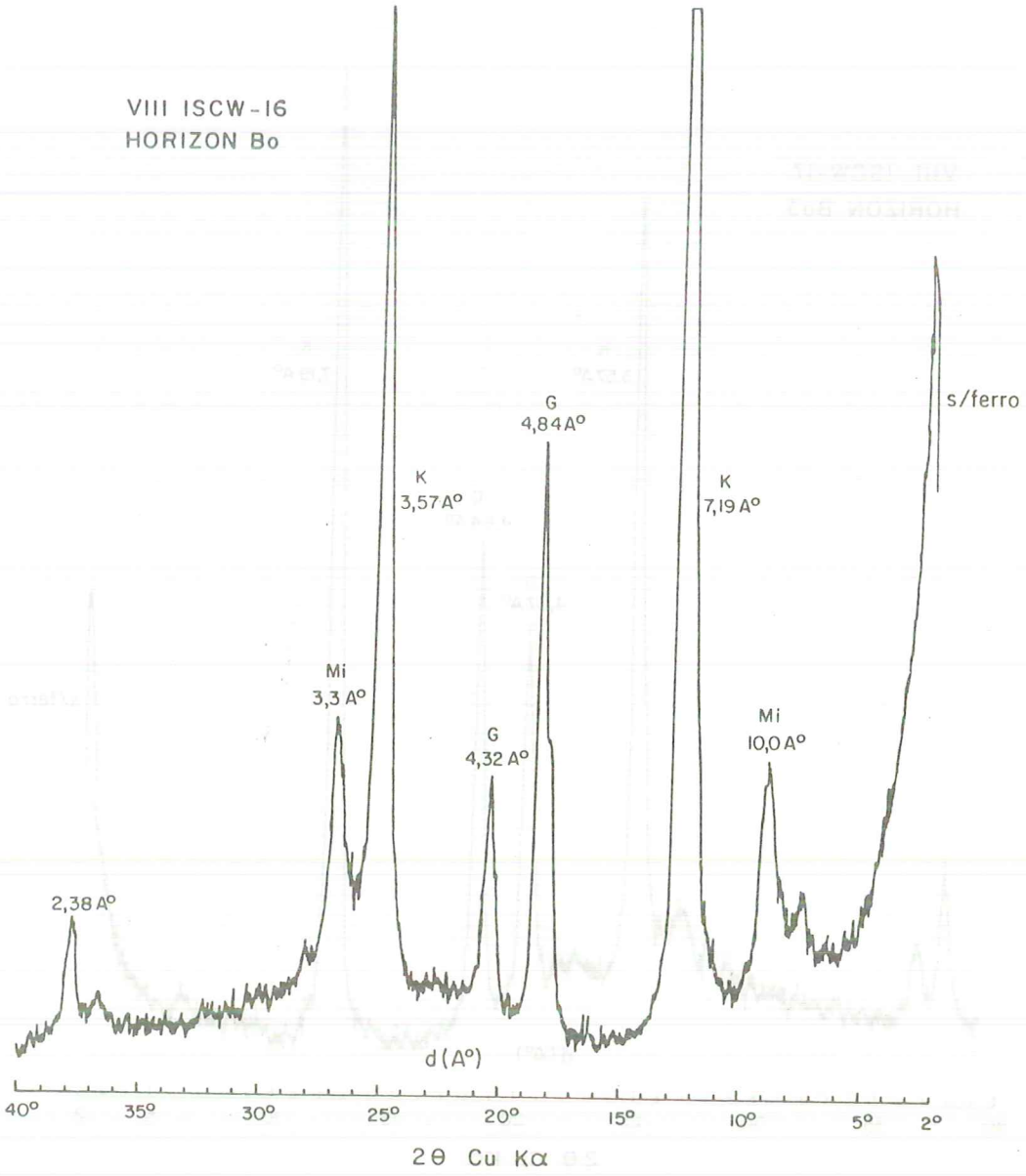

Fig. 19. X-ray diffraction patterns of the deferrified clay from Bo horizon of pedon 16. Units of d spacing are in angstrom Å. Kaolinite (K); gibbsite (G); mica (Mi).

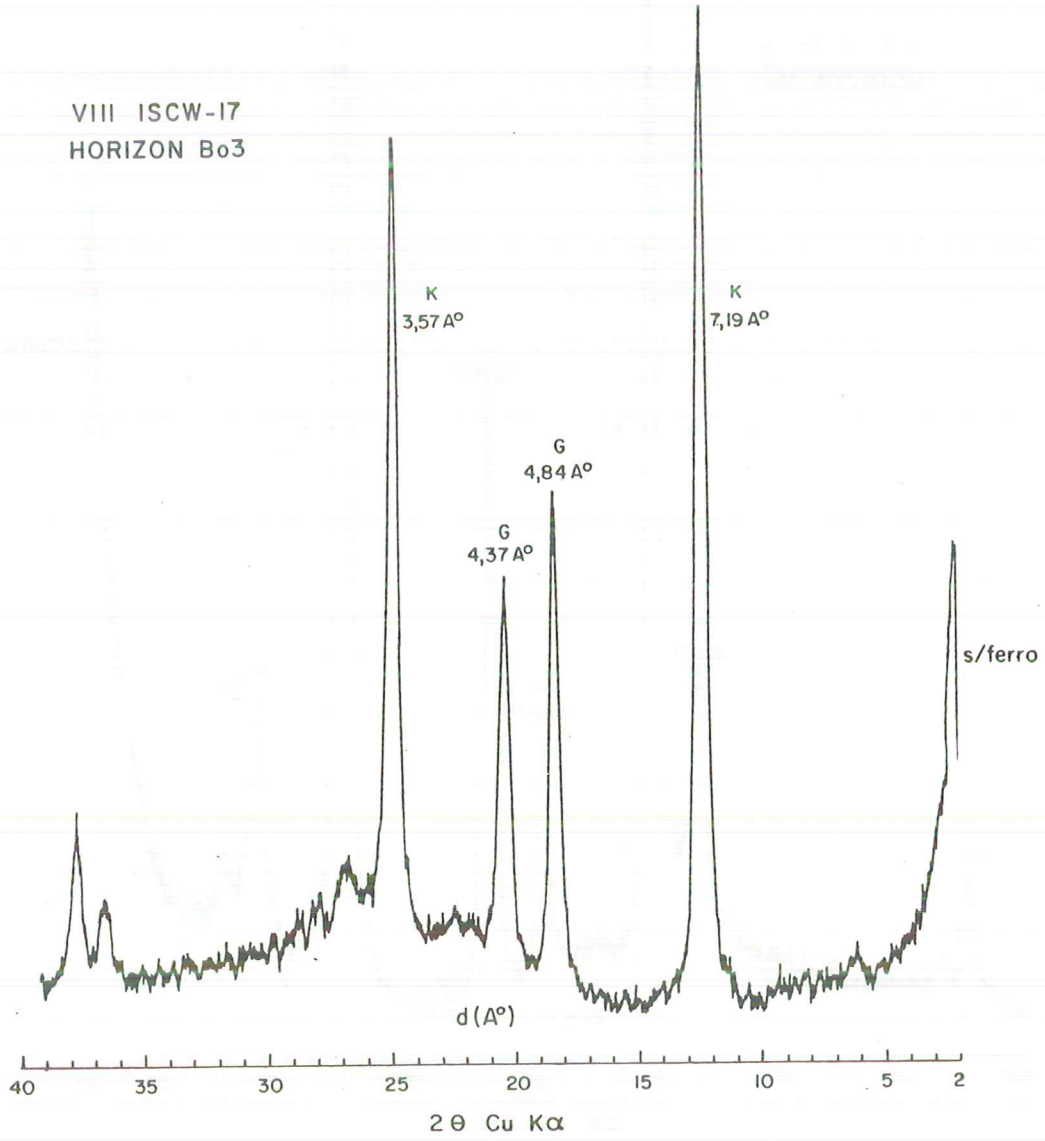

Fig. 20. X-ray diffraction patterns of the deferrified clay from Bo3 horizon of pedon 17. Units of d spacing are in angstrom Å. Kaolinite (K); gibbsite (G).

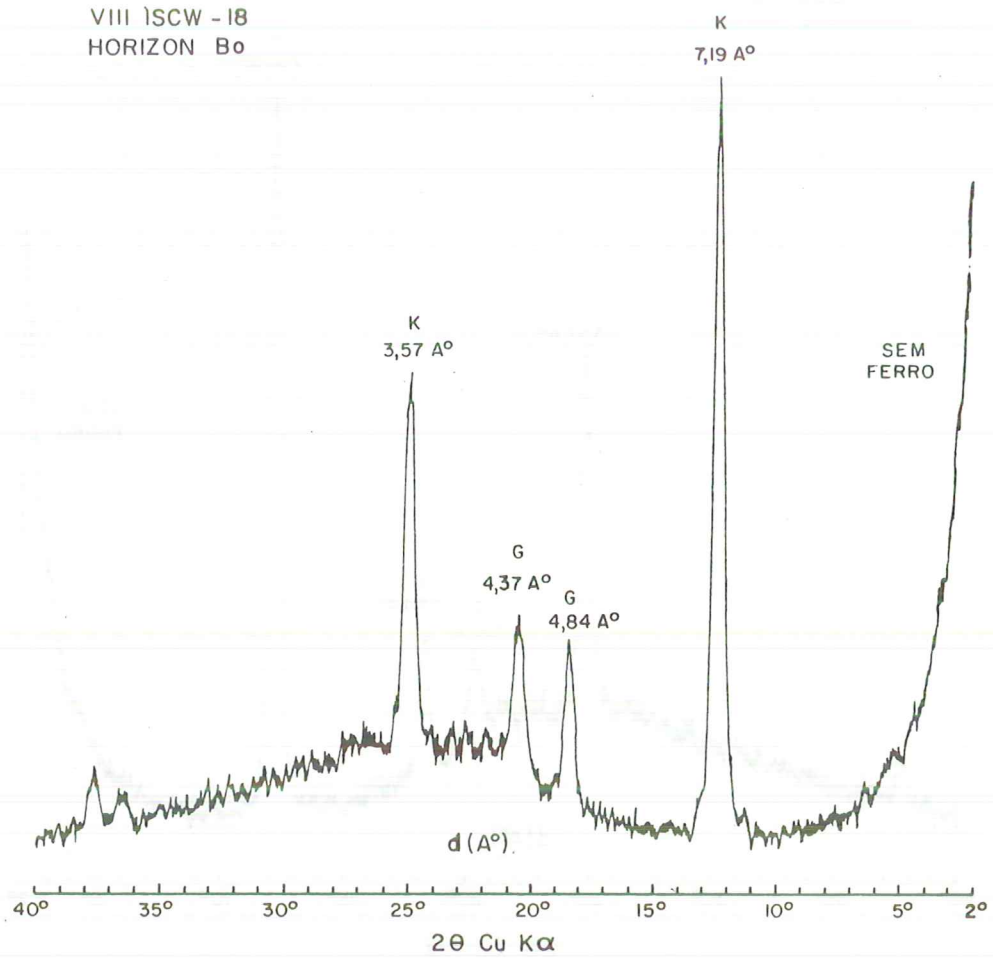

Fig. 21. X-ray diffraction patterns of the deferrified clay from Bo horizon of pedon 18. Units of d spacing are in angstrom Å. Kaolinite (K); gibbsite (G).

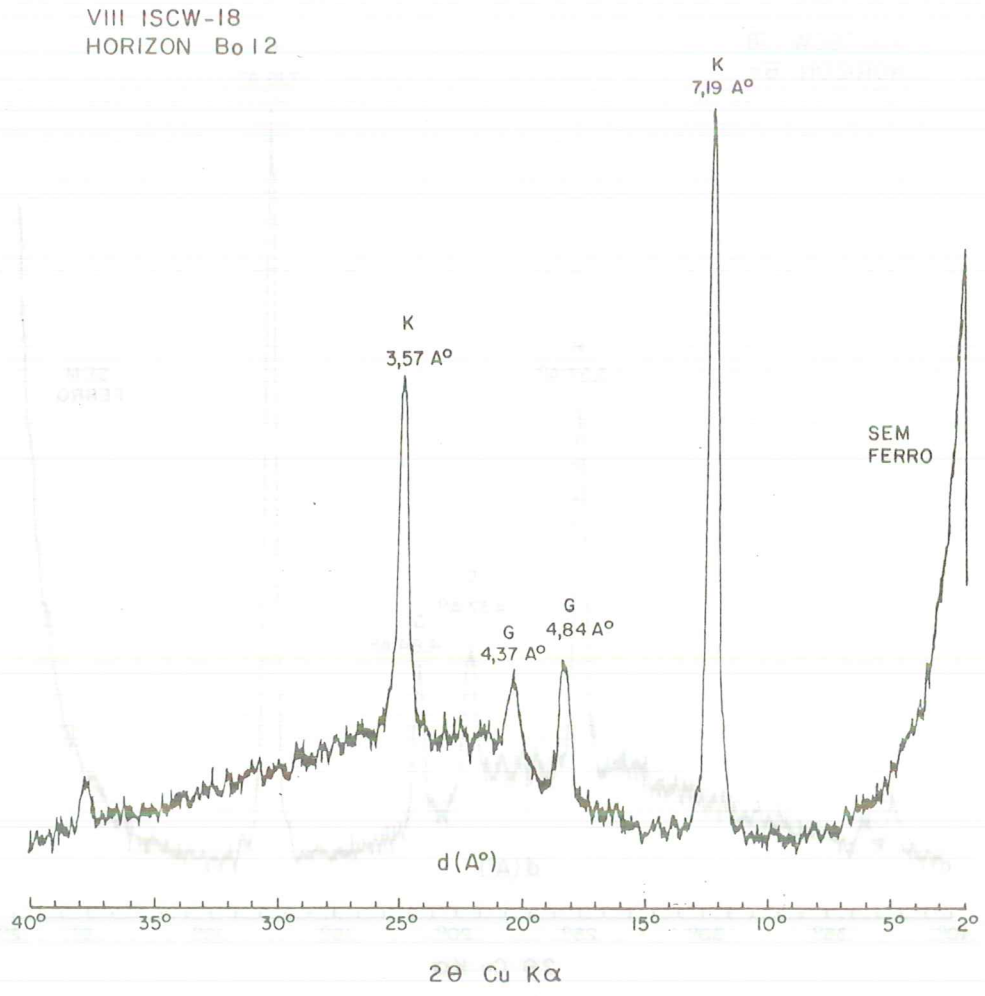

Fig. 22. X-ray diffraction patterns of the deferrified clay from Bo12 horizon of pedon 18. Units of d spacing are in angstrom Å. Kaolinite (K); gibbsite (G).

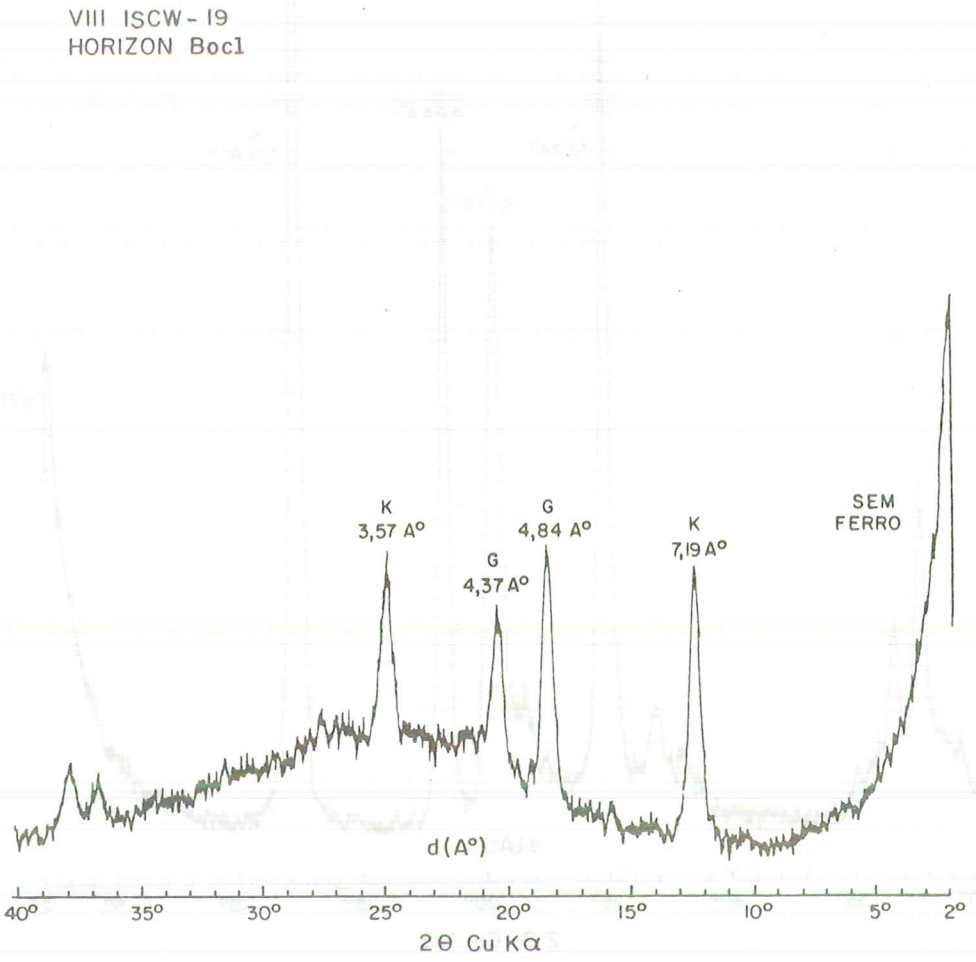

Fig. 23. X-ray diffraction patterns of the deferrified clay from Bocl horizon of pedon 19. Units of d spacing are in angstrom Å. Kaolinite (K); gibbsite (G).

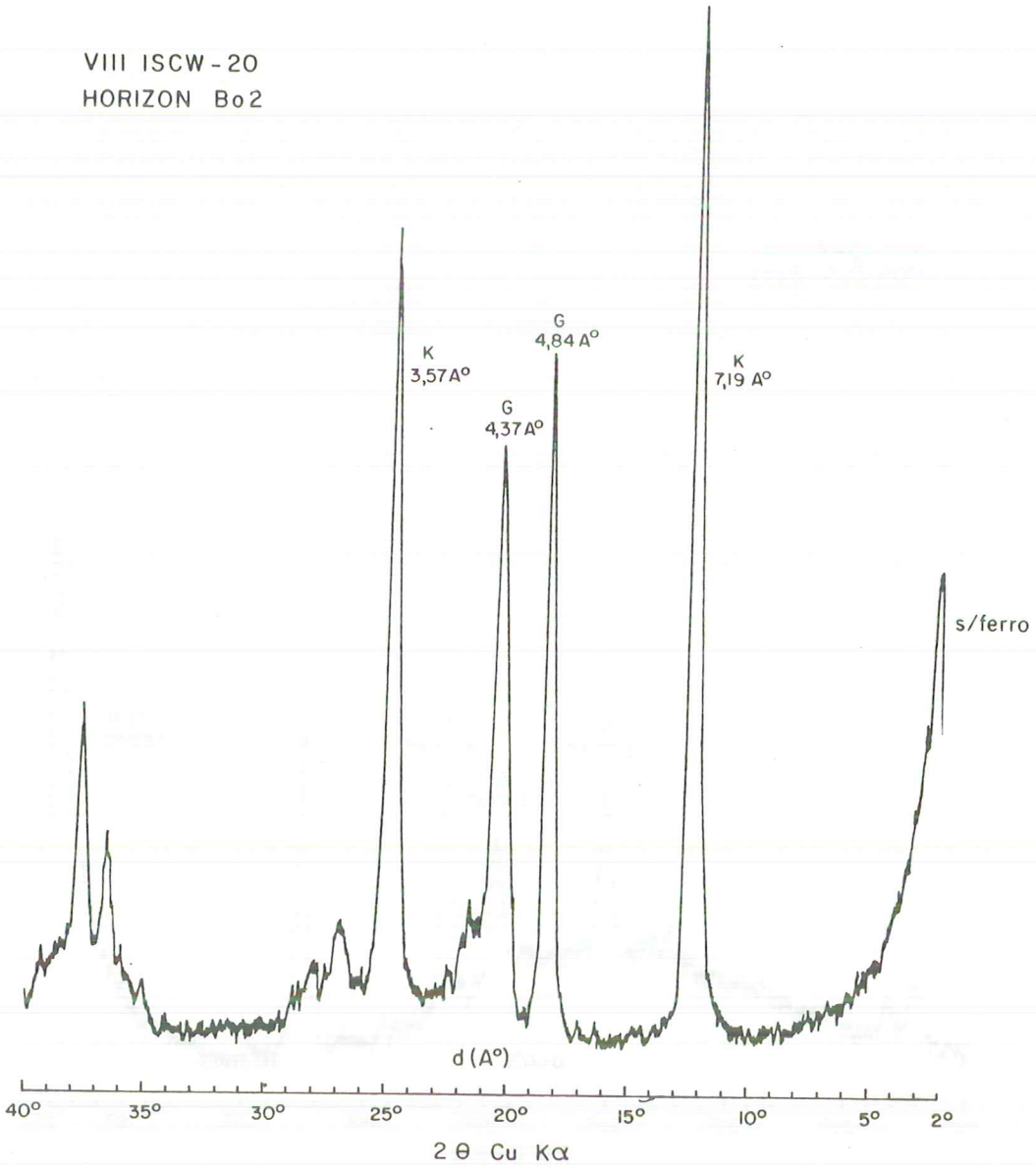

Fig. 24. X-ray diffraction patterns of the deferrified clay from Bo2 horizon of pedon 20. Units of d spacing are in angstrom Å. Kaolinite (K); gibbsite (G).

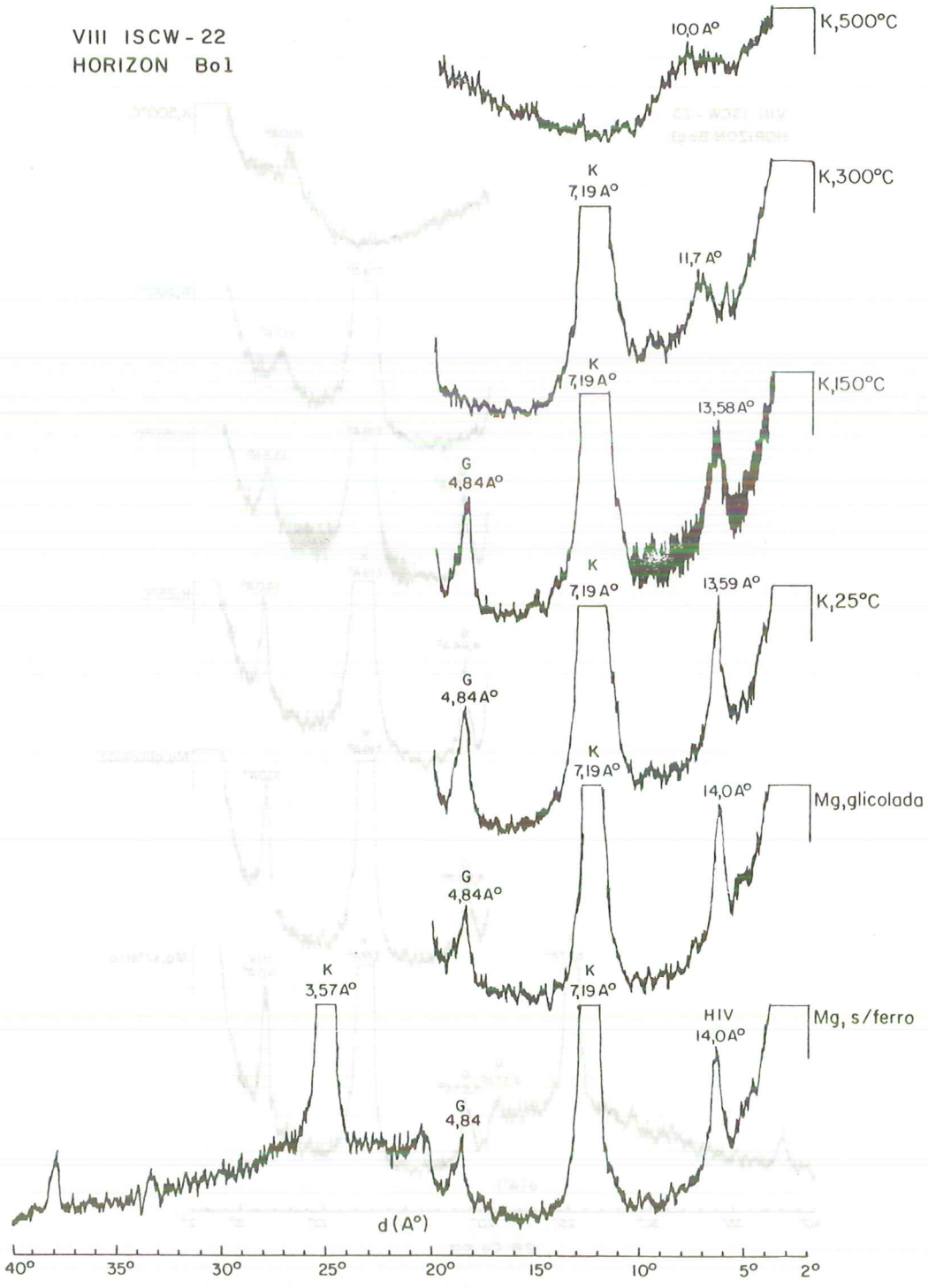

Fig. 25. X-ray diffraction patterns of the deferrified clay from Bo1 horizon of pedon 22 after Mg saturation and glycerol solvation, K saturation at room temperature (K 25°C), heating at 150°C, 300°C, and 500°C. Units of d spacing are in angstrom Å. Kaolinite (K); gibbsite (G); hydroxy-interlayered vermiculite (HIV).

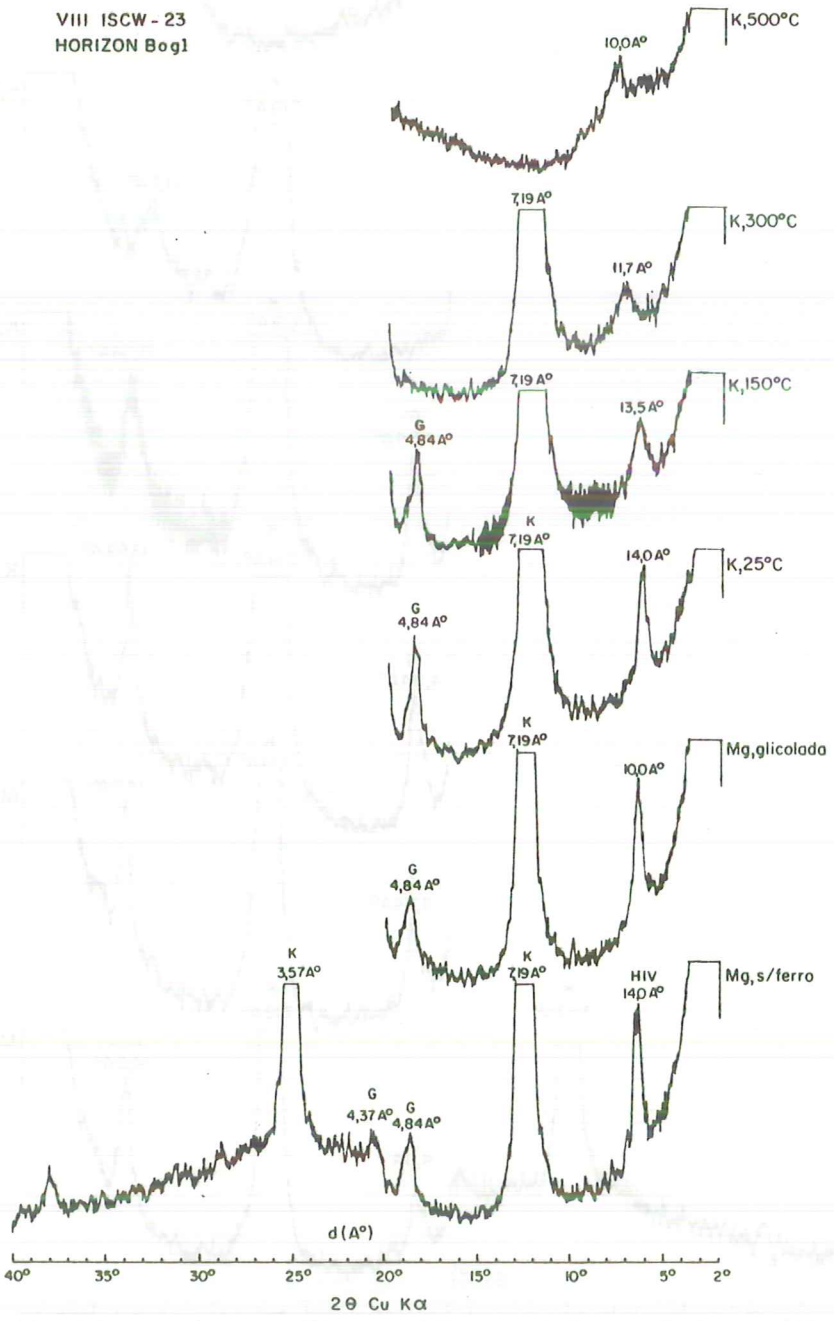

Fig. 26. X-ray diffraction patterns of the deferrified clay from Bog1 horizon of pedon 23 after Mg saturation and glycerol solvation, K saturation at room temperature (K 25°C), heating at 150°C, 300°C, and 500°C. Units of d spacing are in angstrom Å. Kaolinite (K); gibbsite (G); hydroxy-interlayered vermiculite (HIV).

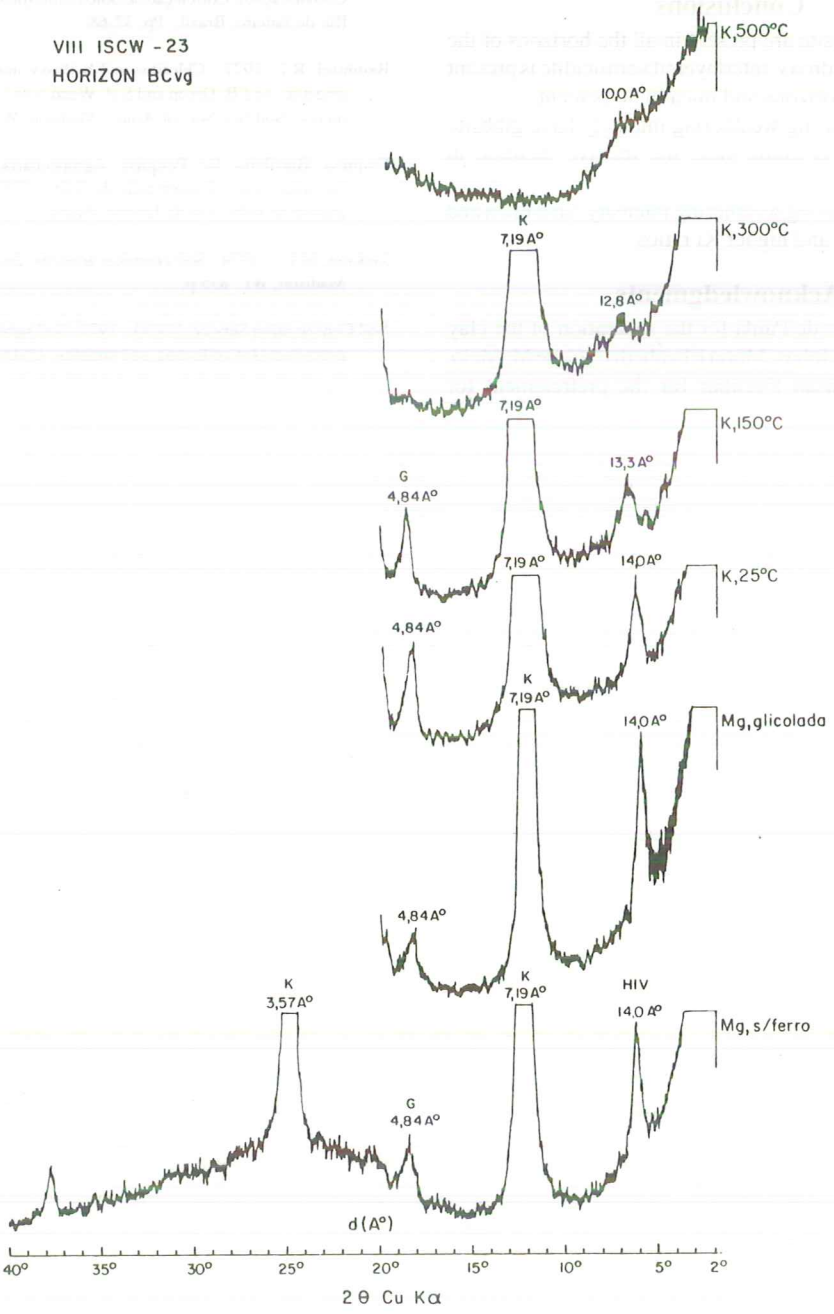

Fig. 27. X-ray diffraction patterns of the deferrified clay from BCvg horizon of pedon 23 after Mg saturation and glycerol solvation, K saturation at room temperature (K 25 °C), heating at 150°C, 300°C, and 500°c. Units of d spacing are in angstrom Å. Kaolinite (K); gibbsite (G); hydroxy-interlayered vermiculite (HIV).

formation of clay minerals, so pedons with increasing weathering intensity have gibbsite increase and pedons with decreasing weathering intensity have HIV and mica content increase.

Conclusions

Kaolinite and gibbsite are present in all the horizons of the pedons examined. Hydroxy-interlayered vermiculite is present in 52 percent of the horizons and mica in 30 percent.

Pedons with increasing weathering intensity have gibbsite increase and lower Ki ratios (note the relative increase in aluminum).

Pedons with decreasing weathering intensity have mica and HIV content increase and higher Ki ratios.

Acknowledgments

Thanks to J. Lopes de Paula for the separation of the clay fraction; to Ruth A. L. Johas, Maria Elizabeth C. C. de M. Melo, and Rosa Lea Bensusan Dechliar for the pretreatment for mineralogical analysis; and to C. Chaffin for drafting the figures.

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