Nontronite $(Ca_{0.5}, Na)_{0.3}Fe^{3+}_2(Si, Al)_4O_{10}(OH)_2 \cdot nH_2O$

Crystal Data: Monoclinic. *Point Group:* $2/m$. Rarely as small bladed crystals, radial or reticulated, spherulitic; commonly cryptocrystalline, claylike, massive.

Physical Properties: *Cleavage:* {001}, perfect. *Fracture:* Conchoidal, splintery. Hardness = 1–2 D(meas.) = 2.2–2.3 D(calc.) = n.d. Positive identification of minerals in the smectite group may need data from DTA curves, dehydration curves, and X-ray powder patterns before and after treatment by heating and with organic liquids.

Optical Properties: Translucent to nearly opaque. *Color:* Yellow, olive-green, green, orange, brown, may be zoned. *Luster:* Waxy, resinous, dull.
Optical Class: Biaxial (–). *Pleochroism:* X = yellowish; Y = yellow-green to dark brown; Z = olive-green to light brown. *Orientation:* $X \simeq c$; $Y = b$; $Z \simeq a$. *Absorption:* $Z > Y > X$ or $Y > Z > X$. $\alpha = 1.567$–1.600 $\beta = 1.604$–1.632 $\gamma = 1.605$–1.643 2V(meas.) = 25°–68°

Cell Data: *Space Group:* $C2/m$. $a = 5.23$–5.26 $b = 9.08$–9.12 $c = 14.8$–15.8 $\beta = \sim 90°$ Z = n.d.

X-ray Powder Pattern: Nontron, France.
15.4 (vs), 4.56 (vs), 2.64 (vs), 2.56 (vs), 1.52 (vs), 2.43 (s), 1.72 (s)

Chemistry:

	(1)	(2)		(1)	(2)
SiO_2	48.82	40.25	CaO		2.29
TiO_2		0.03	H_2O^+		7.25
Al_2O_3	4.30	5.50	H_2O^-		15.09
Fe_2O_3	35.88	29.44	H_2O	9.66	
MgO	0.35	0.53	Total	99.01	100.38

(1) Nontron, France. (2) Colfax, Washington, USA; corresponds to $Ca_{0.43}(Fe^{3+}_{1.93}Mg_{0.07}Al_{0.06})_{\Sigma=2.06}(Si_{3.50}Al_{0.50})_{\Sigma=4.00}O_{10}(OH)_2 \cdot nH_2O$.

Mineral Group: Smectite group.

Occurrence: A weathering product of basalts, kimberlites, and other ultramafic igneous rocks; in poorly-drained volcanic ash soils; in some hydrothermally altered mineral deposits, midocean ridge basalts, and contact metamorphosed limestones. An authigenic mineral in recent marine sediments.

Association: Quartz, "opal," "hornblende," pyroxenes, olivine, mica, kaolinite.

Distribution: Some localities for well-characterized material include: near Saint-Pardoux, Dordogne, France. At Froland, Norway. From Vittensten, Sweden. In Russia, at Okhansk, Perm. From Geilsdorf and Wolkenstein, Saxony, Germany. At Faratsiho, Madagascar. In the Burra copper mine, South Australia, and the Tamworth copper mine, Attunga, New South Wales, Australia. In the USA, in the Spruce Pine district, Mitchell Co., North Carolina; near Colfax and Garfield, Whitman Co., Washington; from Petaluma, Sonoma Co., Crestmore, Riverside Co., and near Woody, Kern Co., California. In New Mexico, at Santa Rita, Grant Co.; from Morenci, Greenlee Co., the Globe-Miami district, Gila Co., the Twin Buttes mine, Pima Co., and at Ray, Pinal Co., Arizona. From Santa Eulalia, Chihuahua, Mexico.

Name: For the occurrence near Saint-Pardoux, Nontron Arrondissement, France.

Type Material: Harvard University, Cambridge, Massachusetts, USA, 89645.

References: (1) Dana, E.S. (1892) Dana's system of mineralogy, (6th edition), 701–702 [chloropal]. (2) Deer, W.A., R.A. Howie, and J. Zussman (1963) Rock-forming minerals, v. 3, sheet silicates, 226–245. (3) Nagelschmidt, G. (1938) On the atomic arrangement and variability of members of the montmorillonite group. Mineral. Mag., 25, 140–155. (4) Isphording, W.C. (1975) Primary nontronite from the Venezuelan Guayana. Amer. Mineral., 60, 840–848. (5) Besson, G., A.S. Bookin, L.G. Dainyak, M. Rautureau, S.I. Tsipursky, C. Tchoubar, and V.A. Drits (1983) Use of diffraction and Mössbauer methods for the structural and crystallochemical characterization of nontronites. J. Applied Cryst., 16, 374–383.