American Mineralogist, Volume 61, pages 500–501, 1976

Primary nontronite from the Venezuelan Guayana: additional primary occurrences (Red Sea, Lake Malawi)

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Abstract

Nontronite precipitating at the sediment/water interface in the Red Sea and in Lake Malawi from thermal solutions rich in Fe^{++} and dissolved silica supports the suggested "primary" origin of a Venezuelan nontronite described recently.

In an article recently published in this journal, Isphording (1975) describes a new occurrence of nontronite "where its origin is apparently related to direct crystallization from high temperature waters. The mineral is further unique in that it contains only a very small percentage of alumina *etc.*" (p. 840).

According to our knowledge, at least two other occurrences of recent nontronite have been previously recorded in which a primary origin, *i.e.* a direct precipitation from solutions, is most probable. Bischoff (1972) described the present-day formation of a nontronite rich in ferrous iron and low in aluminium ("ferroan nontronite") in the Red Sea Geothermal System; Müller and Förstner (1973) observed the precipitation of nontronite from geothermal solutions at the sediment/water interface in Lake Malawi (formerly known as Lake Nyasa) in the East African rift system. In both cases the precipitation mechanism appears to be very similar: thermal solutions rich both in Fe^{++} and dissolved silica discharge on the sea or lake floor. During mixing with sea or lake water, nearly all Fe^{++} (Lake Malawi) or at least large amounts thereof (Red Sea) are oxidized, leading to the precipitation of nontronite. In more highly aerated areas of Lake Malawi, iron hydroxides ("limonite") + opal precipitate simultaneously at a slightly higher redox potential instead of nontronite. Figure 1 describes the situation encountered in Lake Malawi in an Eh-pH diagram. The asssumption that silica glass is present is verified in Lake Malawi: nontronite directly overlies diatomite beds.

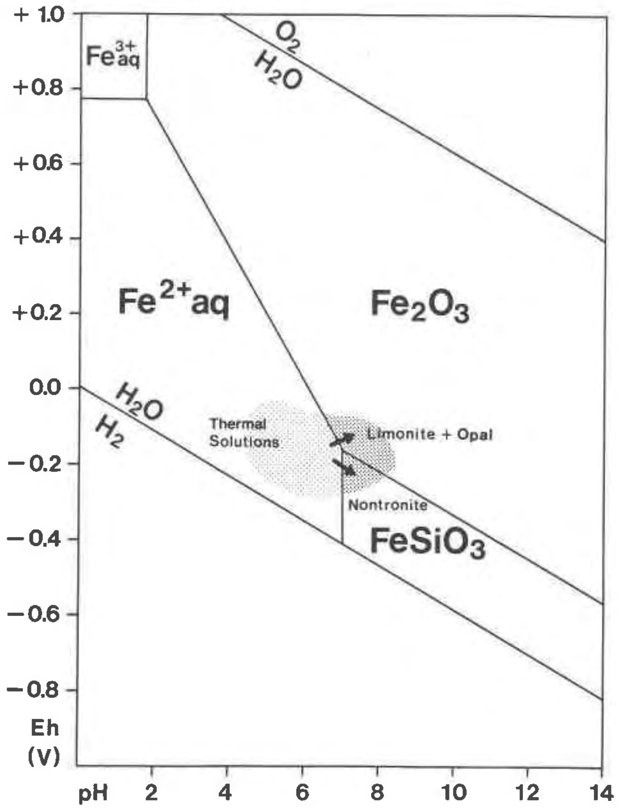

FIG. 1. Eh-pH relationships in Lake Malawi iron ore formation after Müller and Förstner (1973). Since thermodynamic data on nontronite are not known, the diagram of stability relations for iron oxides and iron metasilicate at 25° C and 1 total atmospheric pressure in the presence of water and solid silica glass (Garrels and Christ, 1965) is used instead.

TABLE 1. Chemical composition of "primary" nontronites

	"Primary Nontronite" Venezuelan Guayana (Isphording, 1975)	Recent Nontronite Lake Malawi (Müller + Förstner, 1973)	Recent Ferroan Nontronite, Red Sea, 126 P (Bischoff, 1972)
SiO_2	49.90	42.1	29.3
Al_2O_3	0.27	4.7	1.9
Fe_2O_3	29.50	29.0	32.88
FeO		0.5	6.96
MnO		0.15	0.35
MgO	1.75	0.85	0.81
CaO	0.77	1.15	1.8
Na_2O	0.12	0.45	0.65
K_2O	0.01	0.58	0.5
TiO_2		0.26	
P_2O_5		0.52	
H_2O	16.12	19.8	19.7
CuO+ZnO	-	-	6.51
	98.44	100.06	101.36

The chemical compositions of the nontronite from Venezuela and Lake Malawi are very much alike, with the exception that part of the Si in the tetrahedral sheets is substituted by Al in the Malawi nontronite (table 1).

The proposed origin for the Venezuelan nontronite as being "the product of direct crystallization from siliceous fluids rich in dissolved iron" (Isphording, 1975, p. 847) is strongly supported by Bischoff's and our own observations on recent nontronite formation.

The mechanism of a direct precipitation of iron silicates in lakes and seas might also have played a role in the geological past and could explain the genesis of certain iron-rich sedimentary rocks in the Precambrian iron formations.

References

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Manuscript received, December 7, 1975; accepted for publication, January 19, 1976.