

Wakefieldite-(Nd), a new neodymium vanadate mineral in the Arase stratiform ferromanganese deposit, Kochi Prefecture

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The rare earth elements (REE) concentrations of stratiform ferromanganese ores in Japan are an order of magnitude more than those of average upper continental crust. In spite of high REE concentration, no REE-bearing minerals have been described from the stratiform ferromanganese ores. We have discovered a new Nd-dominant vanadate mineral in the REE-enriched ferromanganese ore specimen.

Wakefieldite-(Nd), NdVO_4 , is a new mineral found from the Arase stratiform ferromanganese deposit in Kochi Prefecture, Shikoku Island, southwest Japan. It is the Nd-dominant analogue of wakefieldite-(Y), wakefieldite-(Ce) and wakefieldite-(La). The ferromanganese ore specimen mainly consists of hematite and caryopilite, wakefieldite-(Nd) typically enclosed to caryopilite. Wakefieldite-(Nd) is tetragonal, $I4_1/amd$, $a = 7.338(16)\text{\AA}$, $c = 6.509(19)\text{\AA}$, $V = 350.5(18)\text{\AA}^3$, $Z = 4$. The four strongest lines in the X-ray diffraction pattern [$d(\text{\AA})$, I/I_0 , hkl] using a Gandolfi camera are (3.67, 100, 200); (2.74, 51, 112); (4.84, 27, 101) and (1.89, 25, 312). Chemical composition of wakefieldite-(Nd) are in V_2O_3 35.25, As_2O_3 0.93, SiO_2 0.14, MnO 1.45, FeO 0.37, Y_2O_3 2.87, La_2O_3 7.61, Ce_2O_3 7.37, Pr_2O_3 6.04, Nd_2O_3 26.79, Sm_2O_3 4.41, Eu_2O_3 1.36, Gd_2O_3 3.41, Tb_2O_3 0.22, Dy_2O_3 1.41, Er_2O_3 0.10, total 99.73 wt.%. The empirical formula is $(\text{Nd}_{0.403}\text{La}_{0.118}\text{Ce}_{0.114}\text{Pr}_{0.093}\text{Y}_{0.064}\text{Sm}_{0.064}\text{Mn}_{0.052}\text{Gd}_{0.048}\text{Eu}_{0.020}\text{Dy}_{0.019}\text{Fe}_{0.007})\text{VO}_4$ on the basis of $\text{O} = 4$. The calculated density is 4.782 g/cm^3 .

Microtexture and co-existing relationship between wakefieldite-(Nd) and caryopilite suggest that recrystallization and dehydration of Fe- and Mn-oxyhydroxide led to the generation of hematite, caryopilite, rhodochrosite and wakefieldite-(Nd) by metamorphism during accretionary process. Chondrite-normalized REE pattern of whole-rock composition of the Arase ferromanganese ore, which is regarded as oceanic metalliferous sediment in origin, shows negative Ce anomaly. Chemical composition of wakefieldite-(Nd) reflects Ce-depleted bulk composition of REE-enriched ferromanganese ore.