Hydrous olivine defect reactions

List of defects

Description	Label	Kroger-Vink	Formula	Peak (cm^{-1})
Ti on an M site, likely M1, a Si vacancy and ferric iron	[Ti-anhyd]	$\{Ti^{**}_{M1} - V^{''''}_{Si} - 2(Fe^{3+})^{*}_{M}\}$	$MgTiFe_2SiO_8$	None
Titanium clinohumite. See, e.g., Walker et al. 2007	[Ti-2H]	$\{Ti^{**}_{M1}\text{-}V^{''''}_{Si}\text{-}2(OH)^{*}_{O}\}$	$MgTiH_2O_4$	3525, 3573
A Si vacancy and $4H^{+}$	[Si-4H]	$\{V^{''''}_{Si}\text{-}4(OH)^{*}_{O}\}$	$Mg_2H_4O_4$	3600
A Si vacancy and 4 ferric irons on M sites	[Si-anhyd]	$\{V^{''''}_{Si}\text{-}4(Fe^{3+})^{*}_{M}\}$	Fe_4SiO_8	None
A Si vacancy, $2H^{+}$, and 2 ferric irons on M sites	[Si-2H]	$\{V^{''''}_{Si}\text{-}2(Fe^{3+})^{*}_{M}\text{-}2(OH)^{*}_{O}\}$	$Fe_2H_2O_4$	3600
A metal vacancy, a ferric iron on an M site, and H^{+}	[tri-H]	$\{V^{''}_{M}\text{-}(Fe^{3+})^{*}_{M}\text{-}(OH)^{*}_{O}\}$	$FeHSiO_4$	3356
A metal vacancy and 4 ferric irons on M sites	[tri-anhyd]	$\{V^{''}_{M}\text{-}2(Fe^{3+})^{*}_{M}\}$	$MgFe_2Si_2O_8$	None

Fast diffusion in and out (decoration of pre-existing Ti defects)

Overview

[Ti-anhyd] + H_2 = [Ti-2H]

Kroger-Vink

$\{Ti^{**}_{M1} - V^{""}_{Si} - 2(Fe^{3+})^{*}_{M}\} + H_2 = \{Ti^{**}_{M1}\text{-}V^{""}_{Si}\text{-}2(OH)^{*}_{O}\} + 2Fe^{x}_{M}$

Formula

$MgTiFe_2SiO_8 + H_2 = MgTiH_2O_4 + Fe_2SiO_4$

Slow redistribution of H between Si vacancies

Overview

[Ti-anhyd] + [Si-4H] → [Ti-2H] + [Si-2H]

Kroger-Vink

$\{Ti^{**}_{M1} - V^{""}_{Si} - 2(Fe^{3+})^{*}_{M}\} + \{V^{""}_{Si}\text{-}4(OH)^{*}_{O}\} \rightarrow \{Ti^{**}_{M1}\text{-}V^{""}_{Si}\text{-}2(OH)^{*}_{O}\} + \{V^{""}_{Si}\text{-}2(Fe^{3+})^{*}_{M}\text{-}2(OH)^{*}_{O}\}$

Formula

$MgTiFe_2SiO_8 + Mg_2H_4O_4 \rightarrow MgTiH_2O_4 + Fe_2H_2O_4 + Mg_2SiO_4$

Alternative: full dehydration of [Si]

2[Ti-anhyd] + [Si-4H] → 2[Ti-2H] + [Si-anhyd]

Redistribution of H in Kilauea Iki at 800C

Overview

[Si-anhyd] + 4[tri-H] → [Si-4H] + 4[tri-anhyd]

Kroger-Vink

$\{V^{""}_{Si}\text{-}4(Fe^{3+})^{*}_{M}\} + 4\{V^{"}_{M}\text{-}(Fe^{3+})^{*}_{M}\text{-}(OH)^{*}_{O}\} \rightarrow \{V^{""}_{Si}\text{-}4(OH)^{*}_{O}\} + 4\{V^{"}_{M}\text{-}2(Fe^{3+})^{*}_{M}\}$

Formula

$Fe_4SiO_8 + 4FeHSiO_4 + 3Mg_2SiO_4 \rightarrow Mg_2H_4O_4 + 4MgFe_2Si_2O_8$