Effect of high temperature oxidation on ferric iron and precipitates in
olivine from andesitic scoria of Kasayama volcano, Japan

T. Ejima (1), M. Akasaka (2), T. Nagao (3), and H. Ohfuji (4)

(1) Shimane, Matue, Japan (olivinefe3@yahoo.co.jp), (2) Shimane, Matue, Japan (akasaka@rico.shimane-u.ac.jp), (3)
Yamaguchi, Yamaguchi, Japan (tnagao@yamaguchi-u.ac.jp), (4) Ehime, Matsuyama, Japan(Ohfujih@yahoo.co.jp)

Occurrence of ferric iron and precipitates within olivine phenocrysts in orthopyroxene-olivine andesitic scoria from
Kasayama volcano, Hagi, Yamaguchi Prefecture, Japan, were investigated to evaluate an effect of high temperature
oxidation. The scorias in the interior of the Kasayama scoria cone are red and weakly welded, whereas black
scoria and black scoria with reddish-brown tint (red-brownish black scoria) occurs on the outer surface of the cone.
Olivine phenocrysts within black scoria lack precipitate minerals, but those in the red-brownish black scoria contain
small amounts of precipitates at their rims. Olivine phenocrysts in the red scoria contain abundant precipitate
minerals including hematite, enstatite and magnesioferrite. The precipitates form symplectite zones on the rims of
the olivine phenocrysts, symplectite domains in the cores, and fill fractures.

Forsterite contents of olivine are correlated with the volume of precipitates present. Olivines in the black and
red-brownish black scoria contain 79-81 and 82-85 mol% Fo, respectively, whereas those in the red scoria reach
99 mol% Fo. To determine oxidation state of Fe in olivine in the red-brownish black scoria using Mössbauer
spectroscopy, olivine phenocrysts lacking such precipitates and inclusions were separated using an isodynamic
separator and handpicking under a binocular microscope. Purity of the olivine separate was examined by optical
microscopy, electron microprobe analysis, X-ray powder diffraction analysis, Raman spectroscopy, and high-
resolution transmission electron microscopic observation. Since precipitates were not detected in the separated
olivine phenocrysts, oxidation state of iron within olivine phenocryst in the andesitic red-brownish black sco-
ria was determined using $^{57}$Fe Mössbauer spectroscopy. The $^{57}$Fe Mössbauer spectrum of the separate consisted
of three doublets assigned to ferrous iron at M1, ferrous iron at M2 and ferric iron at the octahedral site. The
Fe$^{2+}$:Fe$^{3+}$-ratio is 95(3):5(1). By applying this value to the average iron content, 0.37(4), ferrous iron and ferric
iron are calculated to be 0.35(1) and 0.019(4) apfu, respectively. Since ferric iron within olivine in this study is not
due to any ferric iron-bearing impurity, ferric iron should be located at any site in olivine structure. A quadrupole
splitting value of the ferric iron-Mössbauer doublet (0.53(5) mm/s) in Kasayama olivine significantly lower than
published data for ferric iron at M2 in olivine and in laihunite suggests possible distribution of ferric iron at the less-
distorted M1 site. Ferric iron within olivine in the red-brownish black scoria is considered to have been generated
at high temperatures (perhaps above 800 °C).