

## Blue omphacite in jadeitites from Guatemala and Japan: Crystal chemistry and color origin.

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Blue titanian omphacite has been reported previously in jadeitite from Japan by Miyajima et al. (1997) and in an enclave from the Red Wine complex in Canada by Curtis and Gittins (1978). It is now found in jadeitite from Guatemala. Optical spectroscopy, imaging, and microprobe analyses have been carried out on samples from Quebrada Seca, near Carrizal Grande, Jalapa Dept., Guatemala, and Himekawa and Noguchi, near Itoigawa, Niigata Pref., Japan. In Quebrada Seca jadeitites, omphacite occurs as clots and veins with minor phengite and titanite, trace zircon, monazite, allanite and rutile. Itoigawa jadeitites contain omphacite clots, minor titanite, and intergranular albite and analcime. Although blue color may appear pervasive in these samples, it is always restricted to omphacite in clots and veins.

Blue omphacites have relatively high  $\text{TiO}_2$  content, but  $<1$  wt% is sufficient to produce blue color; otherwise low-to-no-Ti omphacites are green. In a Himekawa sample  $\text{TiO}_2$  reaches  $\geq 7.5$  wt% (0.2 atoms per 6 O) with  $\text{FeO}_T \approx 4$  wt% in 70% Na-cpx. For intense blue omphacite in a Quebrada Seca sample,  $\text{TiO}_2$  is 1.0 – 1.8 wt% (0.02-0.05 apfu),  $\text{FeO}_T \approx 3.5$  wt% in 55-65% Na-cpx.

Optical absorption spectra show a dominant broad absorption band at  $\sim 720$  nm overlapping a less intense one at  $\sim 600$  nm, and a weak, sharp peak at  $\sim 435$  nm on a sloping absorption edge. The first two absorptions are in the region where  $\text{Fe}^{2+} - \text{Fe}^{3+}$  intervalence charge transfer occurs in chain silicates, a well-known source of blue coloring. The association of blue color with elevated Ti content suggests it also plays a role in the coloring. In one sample, omphacite crystals were large enough to manifest pleochroism with blue intensity enhanced when the polarization vector is subparallel to the  $c$  axis, consistent with intervalence charge transfer between adjacent M1 sites, appropriate for  $\text{Fe}^{2+}$ ,  $\text{Fe}^{3+}$ , and  $\text{Ti}^{4+}$ .

In these jadeitites of HP/LT metasomatic origin, there is no tetrahedral Al in the pyroxene, and Ti content generally varies positively with Mg and negatively with Al, but  $\text{Fe}_T$  is uncorrelated. So, the exchange enhancing titanium is probably  $\text{Ti} + (\text{Mg}, \text{Fe}^{2+}) = 2(\text{Al}, \text{Fe}^{3+})$  in the M1 site, and Ti is entering as a sodic pyroxene component, e.g.,  $\text{NaTi}_{0.5}\text{Mg}_{0.5}\text{Si}_2\text{O}_6$ . It appears Ti was carried into these rocks by an omphacite-forming fluid and precipitated as both titanite and omphacite.