

## Water solubility in clinopyroxene

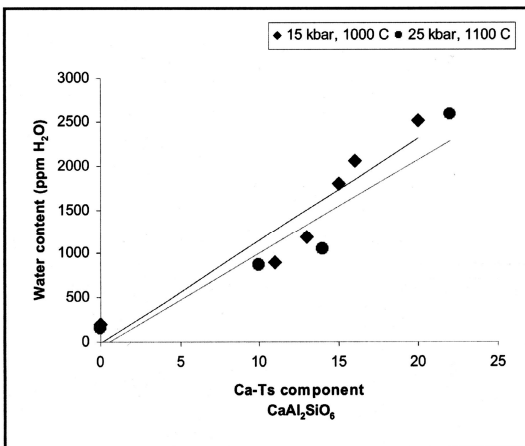
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Clinopyroxenes, in particular omphacites, have the highest water contents among the minerals from mantle xenoliths. In subducting slabs, water in omphacite may contribute significantly to the recycling of water into the mantle. We have therefore measured the solubility of water in both pure  $\text{CaMgSi}_2\text{O}_6$  diopside and in diopside containing variable amounts of aluminum as Ca-Tschermak  $\text{CaAlAlSiO}_6$  component. Single crystals of the pyroxenes were grown in piston-cylinder and multi-anvil experiments using oxide/hydroxide mixtures with excess water as starting materials. Water contents were quantified from polarized infrared spectra of clear single crystals.

Water solubility in pure diopside is rather low, in the order of a few hundred ppm at 1.5 – 3 GPa and 800 – 1100 °C. The type of infrared spectra observed varies with the bulk composition of the sample. Diopside crystals synthesized with excess silica show several bands at low frequency between 3280 and 3480  $\text{cm}^{-1}$ . These bands are attributed to protons on Ca or Mg vacancies. Diopside crystals synthesized with excess MgO or a deficiency of  $\text{SiO}_2$ , which coexist with olivine, show only one sharp band at 3650  $\text{cm}^{-1}$ . This band is therefore probably due to protons associated with silica vacancies.

Water solubility in diopside strongly increases with alumina content and reaches up to 3000 ppm already at 1.5 GPa (Fig. 1). Aluminous diopside samples only show one infrared band at 3650  $\text{cm}^{-1}$ , corresponding to the substitution of  $\text{Al}^{3+} + \text{H}^+$  for  $\text{Si}^{4+}$ . Our data therefore confirm that Al in pyroxenes largely controls water storage in the uppermost mantle.



**Figure 1.** Water solubility in aluminous diopside as function of the content of Ca-Tschermak component (in mol %)

## Cosmogenic $^3\text{He}$ production rate in pyroxenes and olivines at low latitude

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In the past decade cosmogenic  $^3\text{He}$  has become a widely used chronometer of surface exposure. The low cost of noble gas measurements and the relatively high production rate in mafic minerals have, in particular, been exploited for dating exposure of basaltic rocks. Cosmogenic  $^3\text{He}$  production rate in olivine is well documented, however, only few studies have been dedicated to the determination of the production rate in pyroxene (i.e. [1-2], 39-46°N and 47°S latitude). The study presented here is designed to measure long-term cosmogenic  $^3\text{He}$  production rate in pyroxenes and co-existing olivines at low latitudes, and to document the variation of cosmogenic  $^3\text{He}$  production rate with chemical composition.

Four olivine- and pyroxene-rich basalt flows between 132 and 482 m altitude were sampled from Ascension Island (7.5°S) where the arid climate preserves ropey-flow tops. In pyroxenes, cosmogenic  $^3\text{He}$  concentrations were calculated using (i) the magmatic  $^3\text{He}/^4\text{He}$  released by in vacuo crushing and melting, and (ii) the  $^4\text{He}$  concentrations measured by melting. The magmatic  $^3\text{He}/^4\text{He}$  is remarkably constant ( $6.8 \pm 0.4 R_a$ ) while the  $^3\text{He}/^4\text{He}$  of melt extractions range from 100 to 500  $R_a$ , suggesting that the correction for non-cosmogenic He is minimal. Cosmogenic  $^3\text{He}$  concentrations in multiple pyroxene samples from each flow range from  $1.41 \times 10^7$  to  $2.69 \times 10^7$  atoms/g, corresponding to approximately 220 to 350 kyr exposure. Error-weighted mean values have total uncertainties of 5% implying that the flow tops have not been significantly covered or eroded. Measurements of cosmogenic  $^3\text{He}$  concentrations in olivines from the same samples will be conducted and compared to the pyroxenes to constrain the cosmogenic  $^3\text{He}$  production rate in pyroxenes and to explore the production rate variation with chemical composition.

### References

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- [2] R.P. Ackert, B.S. Singer, H. Guillou, M.R. Kaplan, M.D. Kurz (2003) *Earth Planet. Sci. Lett.* **210** 119-136.