Kaersutite in the Chassigny martian meteorite: How much water?

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Kaersutite (Ti-rich amphibole) occurs within olivine-hosted polyphase melt inclusions within the Chassigny martian meteorite. Extensive work has been conducted to assess the compositional characteristics of this mineral because of the potential implications for water on Mars (i.e. Johnson *et al*., 1991; Monkawa *et al*., 2006; Watson *et al*., 1994). Microprobe analyses of F and Cl contents of this kaersutite (Johnson *et al*. 1991) yielded 0.50 and 0.10 wt.% respectively. These low values led to the presumption that much of the amphibole O(3) site was filled with OH^-. However, Watson *et al*. (1994) found very little water in the kaersutite (~0.15 wt.% H_2O), implying that the kaersutite O(3) site is largely occupied by O^{2-}. However, Fe micro-XANES data collected by Monkawa *et al*. (2006) showed that Fe^{3+} comprised only ~5% of the Chassigny kaersutite, which is uncommon for typical terrestrial oxy-rich kaersutites.

When all of the above published data are considered, a structural formula for the Chassigny kaersutite can be calculated based on normalization to 24 anions [best normalizatin scheme for well characterized O(3) occupancy]. The resulting structural formula yields an over-occupied A-site (by ~ 11-15%), which is consistent with having too much O^{2-} in the O(3) site. This inconsistancy suggests either that at least one of the above published data is inaccurate or that the Chassigny kaersutite is not currently representative of its chemical state at the time of crystallization. The first case requires (i) a higher concentration of monovalent anions is present within the O(3) site to decrease the apparent amount of O^{2-} in O(3), (ii) a higher concentration of Fe^{3+} in the M(1-4) sites to diminish the effects of the extra negative charge imposed by O^{2-}, or (iii) a combination of both. The second case would imply that the above data are accurate and the Chassigny kaersutite has changed to an unstable or charge-imbalanced phase subsequent to crystallizing within the melt inclusions. Such a change may have been induced by the shock event that removed the Chassigny dunite from the martian surface (dehydroxylation?). Analyses are ongoing to further assess these possibilities.

References

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Coral reefs and global change: the roles of increasing ocean acidity, ocean temperatures, sea-levels and direct human impacts

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Although coral reefs make up less than 1.2% of the world’s continental shelf area, they represent a disproportionately large and essential resource to people as well as being of immense ecological value. Coral reefs are however sensitive to the threats from global climate change as well as direct human impacts from degradation of their local marine environment, both of which are now occurring at unprecedented rates. Higher levels of atmospheric CO_2 from fossil fuel burning are causing global warming, but also importantly increasing the acidity of the world’s oceans. Increasing ocean acidity and the resultant decrease in the carbonate saturation state of seawater, has the potential to cause substantial reductions in coral calcification. Warming of the world’s oceans has also increased the frequency of unusually warm events resulting in widespread mass coral bleaching, such as occurred in 1998 and 2002. These effects, and the apparent lack of adaptability of corals, is more than counter-balancing any possible beneficial effects from climate change such increased calcification and reduced uptake of CO_2 with higher sea surface temperatures as well as increased accommodation space for coral growth from rising sea levels.

However, arguably the most severe impacts on coral reefs are still those that arise from direct human activities. Locally, landuse changes in river catchments, wetlands and estuaries is leading to increased supplies of sediment and nutrients to many inshore coral reefs. In some cases these, together with pressures from other activities such as trawling and overfishing are now resulting in an evolutionary trajectory that may ultimately result in an abrupt phase shift from a coral to macro-algae dominated ecosystem. It is thus clear that the long-term sustainability of coral reefs is not only dependent on the still poorly understood effects of global climate change and coral adaptability, but also on increasing the resilience of reef systems by mitigating direct human impacts.