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Amorphous Materials: Properties, structure, and durability

North American microtektites are more oxidized than tektites†

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Abstract

Iron oxidation states and coordination numbers have been determined by micro-X-ray absorption near edge spectroscopy (XANES) on the cores of a large group of microtektites from the Australasian, Ivory Coast, and North American (NA) tektite strewn field. The North American microtektites used in this study have been collected from five sites at different distances from the source crater; most have SiO_2 content between 70 and 80 wt%. Accurate analysis of the pre-edge peak energy position and integrated area allowed determination of $Fe^{3+}/(Fe^{2+}+Fe^{3+})$ ratios on all samples with an estimated error of ±0.05.

Microtektites from the Australasian and Ivory Coast strewn fields show low values of the $Fe^{3+}/(Fe^{2+}+Fe^{3+})$ ratios, in fair agreement with tektites from the same strewn field. In contrast, microtektites from the North American strewn fields show a wide range of $Fe^{3+}/(Fe^{2+}+Fe^{3+})$ ratios from 0.02 to ca. 0.61. Comparison of Fe oxidation state data with chemical composition do not show any relation between $Fe^{3+}/(Fe^{2+}+Fe^{3+})$ ratios and Na, Ca, or K contents, thus suggesting that the high-Fe oxidation states are not the consequence of sea-water alteration.

The difference between the Fe oxidation state of tektites and microtektites from the North American strewn fields suggests that some factors in the formation of the North American microtektites were different than for the North American tektites and for microtektites in the other strewn fields.

Previous Fe oxidation state data on NA tektites strongly suggest that the wide range in Fe oxidation state we found on NA microtektites is not related to lateral heterogeneity of the target rocks. Despite a correlation between microtektite oxidation state and distance from the source crater, we maintain that Fe oxidation state is not related only to the microtektite droplet flight distance. This is in keeping with the fact that no significant variations in the Fe oxidation state have been found in microtektites from the Australasian strewn field, even for Australasian microtektites recovered in Antarctica. The Fe oxidation state in North American microtektites could be explained by interaction of melt droplets with a H_2O-rich vapor plumes generated during the impact. These data point out that some difference must exist between the thermal histories of microtektites and tektites from the NA strewn field. Moreover, microtektites from the NA strewn field show also distinctively higher oxidation states than those from Ivory Coast or the Australasian strewn fields.

Keywords: Impact glasses, tektites, microtektites, Fe local structure, XANES