

Cosmogenic ^{36}Cl as Proxy for the Post-Formation History of Tektites

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It is now commonly accepted that tektites are the product of melting and quenching of terrestrial rocks during hypervelocity impact on Earth. This important conclusion has been drawn mainly from the study of cosmogenic radionuclides and the geochemistry of tektites that is in many respects identical to the composition of upper crustal material [1,2]. Cosmogenic radio-nuclides provided not only proof for a terrestrial origin of tektites, but also direct evidence on the nature of the sedimentary precursor and the target stratigraphy. Pal et al. were the first to demonstrate that the ^{10}Be content of Australasian tektites cannot have originated from in-situ production by cosmic rays neither in space nor on earth [3]. The high ^{10}Be contents must have been derived from sediments that have absorbed meteoric ^{10}Be . This conclusion was supported by additional studies including the shorter-lived cosmogenic radionuclide ^{26}Al [4,5].

Motivated by the recent progress in refining the ^{36}Cl systematics and applying the ^{36}Cl techniques to detailed studies of the surface exposure history of rocks [6], we have decided to assess the utility of ^{36}Cl analysis in tektites. The cosmogenic radionuclide ^{36}Cl is produced in-situ by spallation reactions mainly on calcium and potassium, and thermal-neutron-capture on the stable chloride isotope ^{35}Cl . The 0.3 My half-life of the radionuclide ^{36}Cl can furnish information on the exposure history of tektites spanning approximately the past 0.9 My. This limits the applicability of the ^{36}Cl method to the youngest tektites of the Australasian strewn field. Major purpose of this study is to elucidate the post-formation history of tektites.

We have determined the ^{36}Cl , and ^{10}Be and ^{26}Al concentrations in a small set of tektites from the Australasian strewn field using the technique of accelerator mass spectrometry. The range of measured ^{10}Be contents, between about 10^7 at/g and 5×10^8 at/g, agrees well with previously reported values, while the ^{26}Al contents are at or below detection limit, as anticipated. The measured ^{36}Cl concentration range between about 10^6 at/g and 2×10^7 at/g, with the high end populated by the Muong-Nong type tektite. Muong-Nong tektites are geochemically characterized by their high contents of volatile elements including chlorine, compared to other tektites, and the higher ^{36}Cl content is mainly due to thermal-neutron-produced ^{36}Cl . The portion of ^{36}Cl produced by spallation reactions compares well to the "average range" of ^{36}Cl concentrations for this set of tektites. The measured ^{36}Cl content for all tektites exceeds the secular equilibrium concentration, assuming no erosion and exposure at the surface for the past 0.75 My, by as much as a factor of two. Lacking any information on the altitude of the tektites' location of recovery, this equilibrium concentration has been assessed assuming exposure at sea level. An exposure to cosmic rays at an elevation between 1,000 m to 2,000 m could account for the difference in the measured and expected equilibrium contents. Meteoric ^{36}Cl and nucleogenic production of ^{36}Cl cannot account for the elevated ^{36}Cl contents because of the low chloride concentration in most tektites (< 10 ppm). It appears most likely that these tektites spent most of their post-formation history at the Earth's surface. A burial episode early in the history of these

objects, extending for as long as the first few hundred thousand years, cannot be ruled out with certainty.

References: [1] Taylor S. R. (1973) *Earth Sci. Rev.*, 9, 101-123; [2] Koeberl Ch. (1986) *Ann. Rev. Earth Planet. Sci.*, 14, 323-350; [3] Pal et al. (1982) *Science*, 218, 787-789; [4] Yiou F. et al. (1984) *J. Non-crystalline solids*, 67, 503-509; [5] Middleton R. and Klein J. (1987) *Phil. Trans. Royal Soc.*, A323, 121-143; [6] Phillips F. et al (1997) *Geophys. Res. Lett.*, 23, 949-952.