Geophysical Research Abstracts
Vol. 12, EGU2010-9224-1, 2010
EGU General Assembly 2010

Lithium systematics in tektites and impact glasses - implications for their sources, lunar and martian meteorites

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Tektites and impact glasses originate in impact events at very high temperatures as documented by their extreme depletion in volatiles. Previous studies on tektites document different degrees of isotope fractionation depending on the volatility of the respective element. The chalcophile elements Cu, Cd and Zn show pronounced isotope fractionations [1-3] but the lithophile elements Mg, K and B show only minor effects [4-6]. In case of K [5] and B [6], the isotope compositions of the precursor material may be retained in the tektites even after the flash melting at extreme temperatures. The moderately compatible and mildly volatile nature of Li should theoretically preclude large isotope fractionations, consistent with the results for Mg and K. Our new results for moldavites and sediments from central Europe, Muong Nong-type layered tektites, bediasites, australites, Ivory Coast tektites, Libyan Desert glasses (LDGs, for which an impact origin is very likely), zhamanshinites and irghizites, however, show a large range of $\sim$30‰ for δ^7Li. Generally, most of the analyzed tektites show Li systematics similar to that observed in sedimentary materials worldwide (loess, graywackes, pelites, shales). The exception are extreme δ^7Li values $>$25‰ in the generally Li-barren LDGs, formed from nearly pure quartz sand. Such δ^7Li values may reflect the fluvial transport of the precursor sands [7]. Moldavites from the three strewn subfields of moldavites are isotopically homogeneous. Some of the sedimentary lithologies from the Ries crater do not resemble the Li systematics in moldavites which, moreover, are slightly Li-enriched compared to the potential target materials. This may be due to (i) an involvement of a yet unidentified Li-rich precursor in the target (perhaps vegetation [8]), or (ii) a substantial selective enrichment of Li during the melting event. Interestingly, fluvial and fluvio-lacustrine sands that are thought to comprise a large proportion of parental material of moldavites [9, 10] do not have aberrant δ^7Li like the LDGs). Analyses of paired tektite-source laterite preserved at the collection site of layered Muong Nong-type tektites show evidence for humid and mildly tempered climate conditions at the time of the impact event. A broadly negative correlation of Li isotopes with Cu and Zn isotopes in worldwide tektites may suggest a reverse behavior of lithophile and chalcophile elements at plasma temperatures, in line with earlier observations [9].

In general, Li behaves unlike Cu or Zn but its elemental and isotope systematics differ also from those observed for Mg and B. Therefore, Li may be a sensitive tracer of source materials as well as a palaeoclimatic indicator in suitable areas. In addition, Li seems to reliably record isotope systematics of tektitic precursors; therefore, lunar and martian meteorites may keep pristine Li isotope compositions unless terrestrial contamination alters the original signature completely.

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