Nd and Sr isotopic study of Muong Nong and splash-form Australasian tektites. J.D. Blum[1,2], D.A. Papanastassiou[1], C. Koeberl[3] and G.J. Wasserburg[1], (1) Lunatic Asylum, Div. of Geol. & Plan. Sciences, Caltech, Pasadena, CA 91125; (2) Dept. of Earth Sciences, Dartmouth College, Fairchild Science Center, Hanover, NH 03755; (3) Inst. of Geochem., Univ. of Vienna, A-1010 Vienna, Austria.

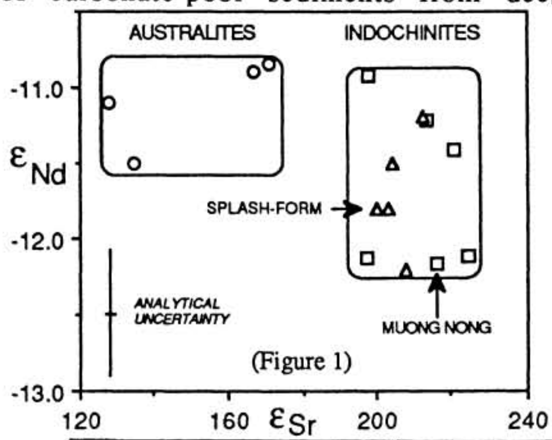
Tektites are natural glasses that belong to either the North American, Ivory Coast, moldavite or Australasian strewn fields. Tektites from each strewn field have a distinct range of ε_{Nd} and ε_{Sr} that reflects the age of crustal material in the impact area [1]. The Australasian is the largest strewn field and is subdivided geographically and chemically into the Indochinites (Laos, Thailand, and Cambodia), Philippinites, Javaites and Australites. The impact event has been dated at ~0.7 Ma [2] and is widely believed to have occurred in or near Indochina. A distinct subgroup of Indochinites are the Muong Nong (MN) tektites which are blocky in form and range in mass up to 24 kg, in contrast to "normal" splash-form tektites which are generally smaller (≤500 g). MN tektites fall into two compositional categories; high-SiO_2 (77-82%) and low-SiO_2 (69-72%) [3]. The high-SiO_2 MN tektites contain relict inclusions of refractory minerals which show evidence of shock [3]. Characteristic features of MN tektites include the presence of alternating light and dark layers, enrichment in volatile trace elements, and abundant bubbles [4].

Muong Nong and splash-form Australasian tektites were analyzed for Nd, Sm, Sr and Rb. The samples analyzed were two low-SiO_2 MN tektites from Laos (X-102 and X-103), three high-SiO_2 MN tektites from eastern Thailand (F-16, 8301 and 8319), and two splash-form tektites from southern Australia (USNM 2537 and 4831). The MN tektite samples have previously been analyzed for major and trace elements [5]. Specimen 8319 was sampled to obtain one sample from only light layers and a second sample from only dark layers. Our isotopic data and the data of [1] are shown in Fig 1. ε_{Nd} for both Australites and Indochinites lie within the 2σ uncertainty (±0.5 εu) of the mean value of -11.7. Nd model ages (T^{Nd}_{CHUR}) range from 1040 to 1190 Ma and indicate that the source material was dominantly a PreCambrian crustal terrane. ε_{Sr} ranges from 128 to 171 for Australites and from 197 to 225 for Indochinites, a variation far in excess of the uncertainty (±0.7 εu). On a Rb-Sr evolution diagram the two low-SiO_2 MN samples are indistinguishable (Fig 2, square symbols). In contrast, the four high-SiO_2 MN samples plot on a line which we interpret as a mixing line between two isotopically different end-members represented by the alternating light and dark layers (Fig 2). If it is assumed that the end-members were once in isotopic equilibrium, an isochron age of 167 (±12) Ma is calculated.

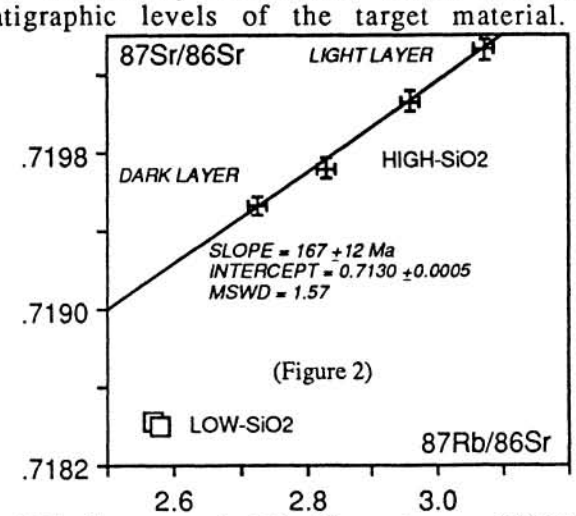
Sr isotopic heterogeneity is found between samples of each subgroup of Australasian tektites [6]. Sr model ages (T^{Sr}_{UR}) for most Australasian tektites range from ~900 to ~300 Ma, which is much younger than T^{Nd}_{CHUR} model ages (~1100 Ma), thus requiring an increase in the Rb/Sr ratio of the tektite source materials after the ~1100 Ma crust-forming event. As shown by [1], this fractionation may be elucidated by plotting the reciprocal of the Rb/Sr enrichment factor (*1/f*) versus T^{Sr}_{UR} (Fig 3). The systematics of this diagram are such that data points which plot as a line on a Rb-Sr evolution diagram, also plot as a line on this diagram but the intercept (rather than the slope) corresponds to the isochron age. In cases where multiple Rb/Sr enrichment events have occurred, data points plot as a wedge-shaped array that points toward the age of the last major Rb enrichment event. Fig 3 shows that all data for Australasian tektites plot within a wedge pointing toward the ~167 Ma age defined by the isochron from the four high-SiO_2 MN tektites (Fig 2).

We interpret the ~167 Ma age as the time of weathering and deposition of sediments that were later melted in a single impact event to form the Australasian tektites. The age is ~100 Ma younger than that inferred by [1] from a simple linear regression of all Australasian tektite Rb-Sr data available at that time. Jurassic and Cretaceous marine sedimentary rocks outcrop over much of eastern Thailand, Laos and Cambodia and are largely sandstones interbedded with shales and carbonates [7]. The variation in ε_{Sr} and Rb/Sr ratios observed in Australasian tektites can be explained by variations in the clay and carbonate content of sedimentary layers [1,6]. Shales generally have high Rb/Sr ratios due to preferential uptake of Rb relative to Sr in clays, whereas carbonates have low Rb/Sr ratios and high Sr contents. The crustal materials that were precursors to the sediments that melted to form the high-SiO_2 MN tektites, probably had similar and moderate Rb/Sr enrichments. This would permit the sediments to be formed with a relatively homogeneous $^{87}Sr/^{86}Sr$, which has allowed the determination of an isochron (Fig 2) whose slope corresponds to the depositional age. The initial $^{87}Sr/^{86}Sr$ from the isochron (Fig 2) and trace element studies [5] are consistent with this model.

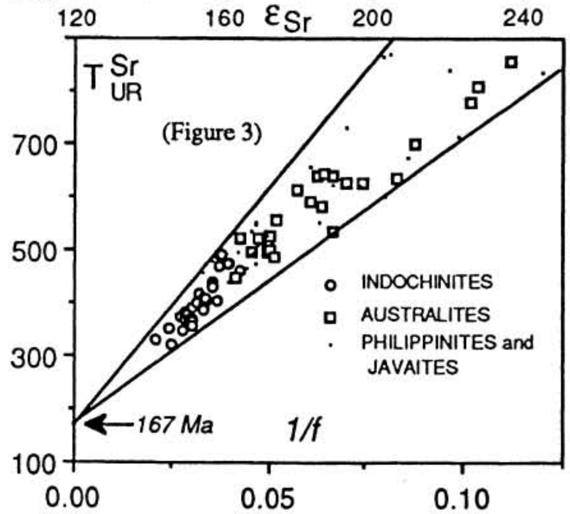
Indochinites have lower Sr contents and higher ε_{Sr} values than Australites. Based on isotopic comparisons of 1) Ries crater impact melts with moldavites and 2) North American tektites with microtektites from a DSDP hole off the New Jersey coast, Stecher et al. [8] suggested that tektites found close to an impact site may sample deeper levels of target material than those found at greater distances. Following this idea we suggest that Australites (which have all fallen >5000 km from the postulated impact site) were generated by severe shock-induced melting of near-surface sediments (containing some carbonate) during the initial stages of impact. In contrast, we suggest that Indochinites were formed by less-severe shock melting of carbonate-poor sediments from deeper stratigraphic levels of the target material.



(Figure 1)



(Figure 2)



(Figure 3)

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