THE HIGHLY OBLIQUE SOURCE IMPACT OF THE AUSTRALASIAN TEKTITE STREWN FIELD IN CHAMPASAK PROVINCE, LAOS.

A. R. Hildebrand[1], [1]Terrext Research Ltd., 3248 Boulton Rd NW, Calgary, AB, Canada T2L 1M3 (abrazosriver@gmail.com).

Introduction: The ~790,000 year-old Australasian tektite strewn field is the largest known on Earth extending across southeastern Asia and Australia to Antarctica (and adjacent ocean basins). The asymmetric strewn field (Fig. 1) has "butterfly wings" and a downrange lobe (and rays) extending southeastwards suggesting that it formed as a result of a highly oblique impact [1]. Variations in tektite size, form, mineralogy, isotopes, and volatile and major element compositions indicate a source in central Indochina, but no expected large crater (≥30 km diameter) has been found [e.g. 2, 3]. A highly oblique impact (e.g., ~5°) also explains why no large crater has been found as impact energy is strongly partitioned into jetting rather than excavation in such cases, yielding a >10 times smaller volume (and potentially structurally simple) crater [4].

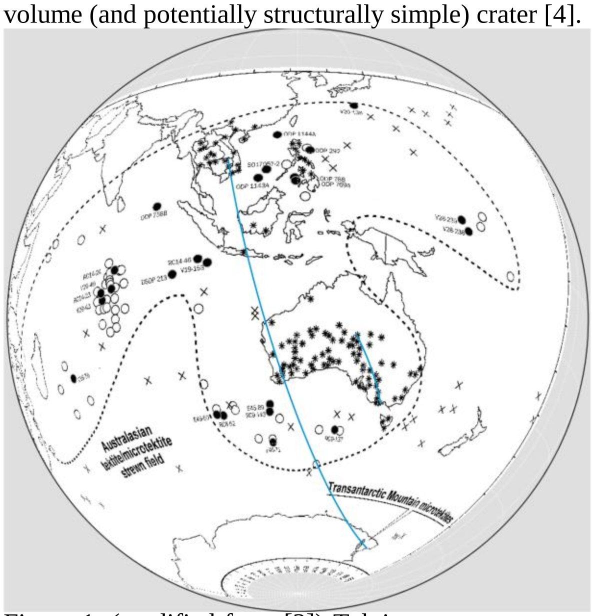
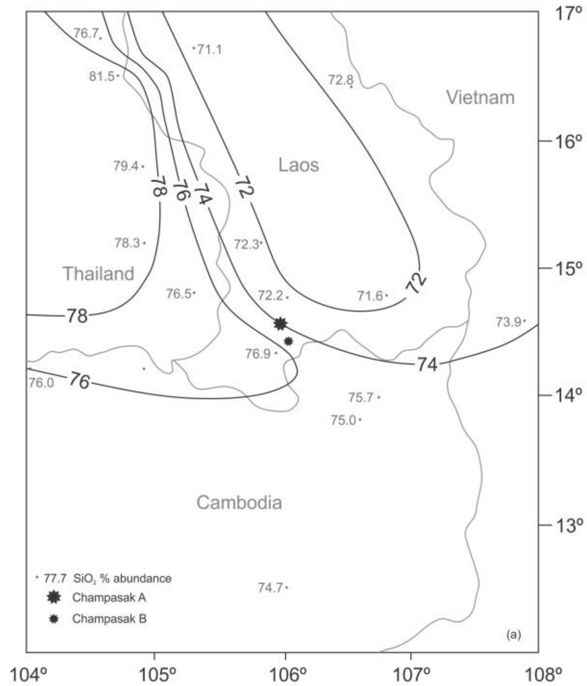
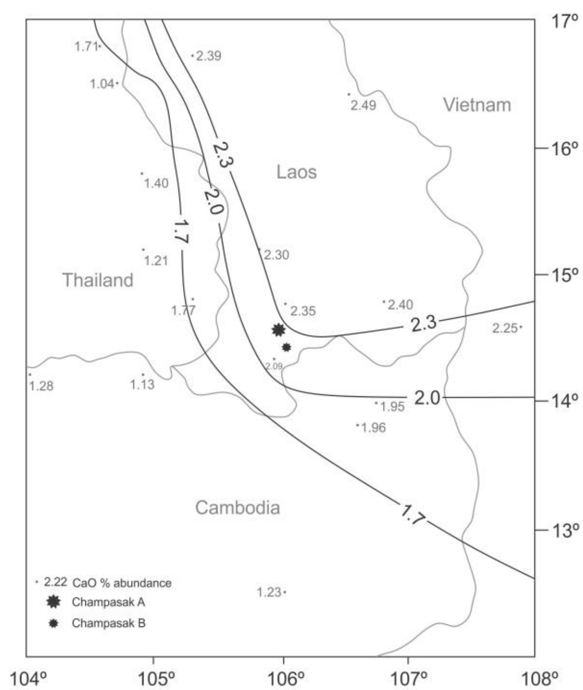


Figure 1: (modified from [3]) Tektite occurrences outlining the Australasian strewn field); gray shaded areas show Antarctic microtektite occurrences. The long blue line shows the great circle projection of the ~167° alignment of the Champasak craters; the short blue line shows a subparallel tektite ray on Australia [5].

Indicators of Source Impact Location: The distribution of the most proximal ejecta type seems the best clue to locating a source crater and many have interpreted the Muong Nong (MN) tektites as the most proximal [e.g., 2, 6]. Schnetzler [2] had proposed that their size distribution and elemental abundance gradients indicated that the source impact had to be located near the southern Laos-Thailand border area (~16°N /105°E); however, available geographic MN recovery limited "resolution" of this analysis. Fieldwork in the region recovered additional tektites that show the source impact is slightly to the southeast (Figs. 2 & 3).





Figures 2 & 3: (modified from parts of Fig. 3a and 3c of [2]) SiO_2 and CaO abundances of MN tektites centred on southern Laos. Data are from [2] with addition of four sites straddling the Laos-Cambodian border. Contours outline total abundance variation. Locations of the Champasak A & B impact craters also shown.

New Muong Nong localities refine impact location. Additional Muong Nong sites straddling the Laos-Cambodian border show that the steep SiO_2 and CaO abundance gradients 1) continue to this area and 2) bend sharply just north of the border, indicating that the source impact is likely at this bend (gradients resulting from diverse ejected material on opposite crater sides reflecting impacted bedrock/protolith variation) . Characterisitics of individual newly recovered tektites support a nearby impact: one has ~5% vesiculation (highest known?) and a second (with strong refractive index variation) has SiO_2 concentrations from 67.1 - 81.5 %, almost the entire observed range from all MN tektites (See Fig. 4 in [2]; Schnetzler suggested proximal tektites would show the greatest internal variation.)

The Champasak Craters: Two elliptical craters occur just north of the Laos-Cambodian border in the southwestern Annamite Mountains (~600 m relief) of Champasak province (Fig. 2): Champasak A (~ 3 by 1.6 km) and Champasak B (~ 1.1 by 0.7 km) located at 14.5094° N; 105.9681° E and 14.4076° N; 105.9923° E , respectively. Both craters are breached to the east and particularly Champasak A has been somewhat enlarged by erosion (weathering and erosion rates are high in this tropical region). Their long axes are oriented at ~165° and the crater doublet is collinear along 167° azimuth; projecting this azimuth bisects the Australasian strewn field and reaches the Antarctic occurrence [3] (Fig. 1). The two craters cut the regional structural lineaments and exhibit some of the steepest slopes in the area, indicating their relatively young age.

The impacted protolith. S. Taylor [e.g., 7] suggested that the Australasian strewn field source terrane was clastic sedimentary rock based on tektite elemental matching and this has been a widespread working hypothesis. However, the craters excavated within a Lower Middle Triassic rhyolitic to dacitic extrusive succession up to 1 km thick [8]. Bedrock exposure is limited, and surface exposures are often weathered, but fieldwork broadly confirms the volcanic succession mapping. The Lower Middle Triassic age (~240 – 250 M.yr.) is tentatively supported by Australasian tektite Rb-Sr isotope systematics, although the data had been interpreted otherwise [9, 10]. The geographic MN elemental variations (Figs. 2 & 3) have been attributed to mixing of different sediment types, but likely reflect rhyolitic to dacitic succession variation.

Champasak A melt sheet. The clast-rich melt rock (Fig. 4) in Champasak A forms a now-dissected melt sheet with thickness of ~50 m remaining near its centre; southwards >150 m of melt may remain. Initial

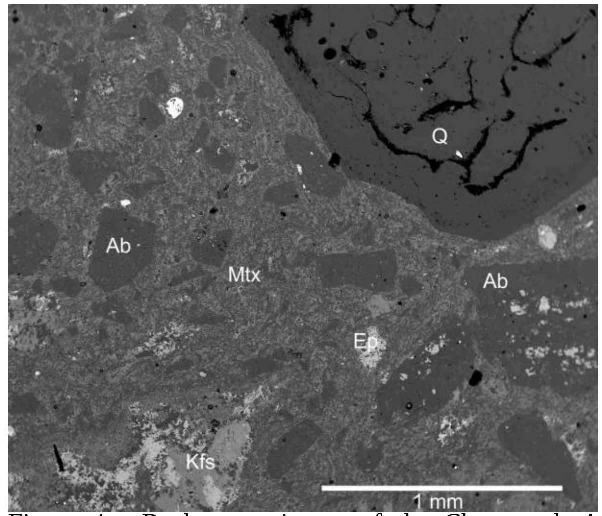


Figure 4: Backscatter image of the Champasak A crater melt sheet; generally the clast-matrix ratio is roughly 1:1.

petrography and microprobe analysis indicate that the melt sheet is relatively homogenous, although the melt-sheet base is clast rich. The melt rock (Fig. 4) is a good match to average MN compositions [e.g., 2] for major elements (assuming alkalis are lost due to volatization); e.g., the matrix of two samples separated ~250 m laterally and ~30 m vertically yielded SiO_2 77.8 & 79.5 % vs. 76.25 %; Al_2O_3 12.67 & 11.39 % vs. 11.1 %; K_2O 6.93 & 5.29 % vs. 2.47 %; Na_2O 1.63 & 2.00 % vs. 1.4 %, respectively. Further work will compare minor and trace elements. The melt sheet contains quartz grains with relatively rare planar deformation features (requiring a universal stage to locate) indicative of shock metamorphism. Erosion has "perched" the melt sheet at some locations on the eastern side; the immediately underlying extrusives have variable levels of cataclasis (which may be due to regional deformation) in contrast to the more massive melt sheet.

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