EXPLORATION OF TEKTITE FORMATION PROCESSES THROUGH WATER AND METAL CONTENT MEASUREMENTS. N. Watt[1] , R. Bouchet[1,2], and C.-T. A. Lee[1], [1]Department of Earth Science, Rice University MS-126, 6100 Main St, Houston, Texas 77005, njw3@rice.edu, [2]Universite de Lyon, CNRS, UMR 5570, Laboratoire de Sciences de la Terre, Ecole Normale Superieure de Lyon, 46 Allee d'Italie, 69364 Lyon Cedex 07, France, romain.bouchet_bert_manoz@ens-lyon.fr.

Introduction: Tektites are glassy rocks which have major element compositions similar to continentally derived crustal rocks on Earth, and are thus interpreted to be melts of crustal material ejected from the site of the impact of an extraterrestrial object on the Earth. However, in terms of volatile elements and species, such as Zn and H_2O, they are extraordinarily depleted relative to the Earth's crust [1] [2]. Because of their origin as the products of extreme heating and volatile depletion, tektites may provide insights into the nature of impact events. For example, the degree to which elements of different volatilities are depleted may provide constraints on the temperature and duration of heating.

Here, we present H_2O, Zn, and Pb concentration data on the same tektite samples and compare the degree of volatile depletion based on these elements and species to the number and nature of bubbles and the physical characteristics of tektites. Our Zn concentration study provides an independent test of Moynier et al.'s hypothesis that Zn was evaporated. The relationships with Pb and H_2O, the latter considered more volatile than Zn, is used to better constrain the conditions of evaporation.

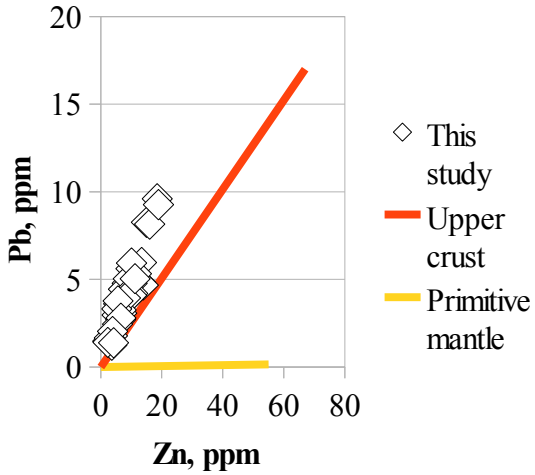
Samples and methods: The tektites used were collected in Da Lat, Vietnam, in the Australasian strewnfield, the impact origin of which remains undetermined, though dated at 0.78 million years ago [1]. All exhibit some level of flow banding – alternating light and dark brown bands associated with melt flow – but the intensity of banding varies widely.

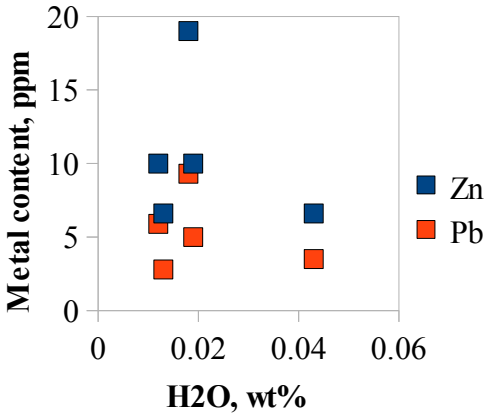
FTIR analysis. We used a Thermo Electron Nicolet Continuum Fourier Transform-Infrared spectroscope to determine water contents of five tektites using absorbance values for rhyolitic glasses [3]. The peak associated with the vibration of H_2O molecules in the neighborhood of 1630 cm^{-1} was measured and used to calculate the water contents of the samples. Ten-measurement moving averages were used to reduce noise.

ICPMS analysis. Laser ablation measurements were done on a ThermoFinnigan Element 2 single collector magnetic sector ICP-MS using a 213 nm New Wave laser. Samples were ablated with an energy flux of 16-18 J/cm^2 at a 10 Hz repetition rate. Spot size from 55 µm diameter. ^{66}Zn was determined in medium mass resolution mode ($m/\Delta m \sim 3000$) and ^{208}Pb in low mass resolution ($m/\Delta m \sim 300$). Long term magnetic drift in medium mass resolution was corrected for during every run by centering on the $^{40}Ar^{40}Ar$ dimer. Hysteresis effects in medium mass resolution were accounted for by applying specific offsets to each mass analyzed. These effects were not important for low mass resolution mode.

All work was done at the Rice University Department of Earth Science, Houston, Texas.

Results: The average water content of our tektites was 0.0209±0.0035% by weight. No correlations between flow band frequency, bubble frequency and water content were observed.





Zn and Pb concentrations (1-9.6 ppm and 2-18.9 ppm, respectively) were highly correlated ($R^2 = 0.89$) and depleted relative to the upper continental crust (Pb ~17 ppm and Zn~67 ppm) [4]. We also find that the Pb/Zn ratio of the tektites (0.49) is higher than that of

upper continental crust (0.25) and primitive mantle (0.00273) [5]. There is no correlation between water contents and Zn or Pb concentrations ($R^2 \leq 0.1$), as shown below.

Motivated by studies attempting to locate the source crater of the Australasian strewnfield from variations in the ^{10}Be activity of tektites from different localities within the strewnfield [6], we compare average water contents of tektites sampled from various localities in the Australasian strewnfield. While there are significant gaps in the water data, it appears that tektite water content decreases with distance from Indochina.

Discussion: Contrary to our expectations of correlated water, zinc, and lead concentrations, water removal does not appear to be linked to volatile metal removal. To assess the plausibility of the water concentrations found, we extended a model of water solubility in rhyolitic liquids to conditions expected for an extraterrestrial impact on the Earth's surface [7].

At the temperatures required for tektite formation [8], the required water vapor mole fraction in the adjacent vapor phase is approximately 0.3.

Conclusions: Different processes are required to explain the water and volatile metal content in tektites. The water content of the tektites was buffered by the water in the ejecta cloud, whereas Zn and Pb are depleted because the vapor cloud was free of Zn and Pb. We conclude that the Australasian strewnfield was created by an impact at a site sufficiently wet to raise the concentration of water vapor in the air. Tektite water content within the Australasian strewnfield decreases with distance from the general area of the presumed impact site. This is expected because, as the tektite travels further from its impact site, it leaves its water-rich ejecta cloud and enters ambient and dry atmosphere

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