3-D VARIATIONS OF WATER CONTENT IN AN INDOCHINITE.

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Introduction: Tektites are shocked natural glasses that appear in several forms, including layered, blocky Muong Nong types, aerodynamically shaped flanges, and splash forms. They frequently contain lechatelierites, vesicles, and flow lines, probably indicating movement within the melt. Water contents in tektites are very low (40–100 ppm by infrared spectroscopic methods [1–3]), lower than the one atmosphere solubility of water in glasses [4]. At such low concentrations, the water is present as OH, which diffuses very slowly in silica-rich liquids and glasses [5]. Variations in tektite water contents were, therefore, not diffusively modified to any great extent, given the 1–10°C/sec cooling rates [6]. What, then, causes almost 3-fold variations in the water contents of these otherwise fairly homogeneous glasses (with respect to major elements [3])?

Analytical Techniques and Sample Description: We studied dissolved total water concentrations using micro-FTIR spectroscopy (Nicolet 60sx spectrometer) in a tear-drop-shaped splash-form tektite from Thailand [3]. 738 measurements have been made in five different cross sections cut perpendicular to the long axis of the indochinite, which was ~6.5 cm long and 2 × 1.3 cm at the largest diameter. The beam size was 114 × 114 µm square and the sections ranged from ~350–700 µm thick. We used the 3550 cm^{-1} band for total water and, because the bulk composition of this tektite is similar to that of rhyolite, we used the calibration of Newman et al. [7], as modified by Dobson et al. [8]. The five analyzed sections were cut parallel to each other from 0.8 to 1.3 cm from the tip of the head of the tektite (Fig. 1). The two sections closest to the head contained a 2-mm-diameter (cross section) bubble intersecting the outer surface of the tektite. Of the three sections closer to the tektite tail, the first contained a dimple, an expression of the termination of this large bubble, which was at least 3.5 mm long. The other two contained no physical indication of the bubble's presence. Other features observed included lechatelierites, generally <25 µm in maximum linear dimension, vesicles ²1 mm in diameter, and flow lines of varying intensity.

Results and Discussion: Measured water concentrations vary from 28 to 112 ppm with a mean of 78 ppm, although the mean for the section closest to the head is somewhat higher than the others, 91 ppm. There are no significant differences among the means of the others.

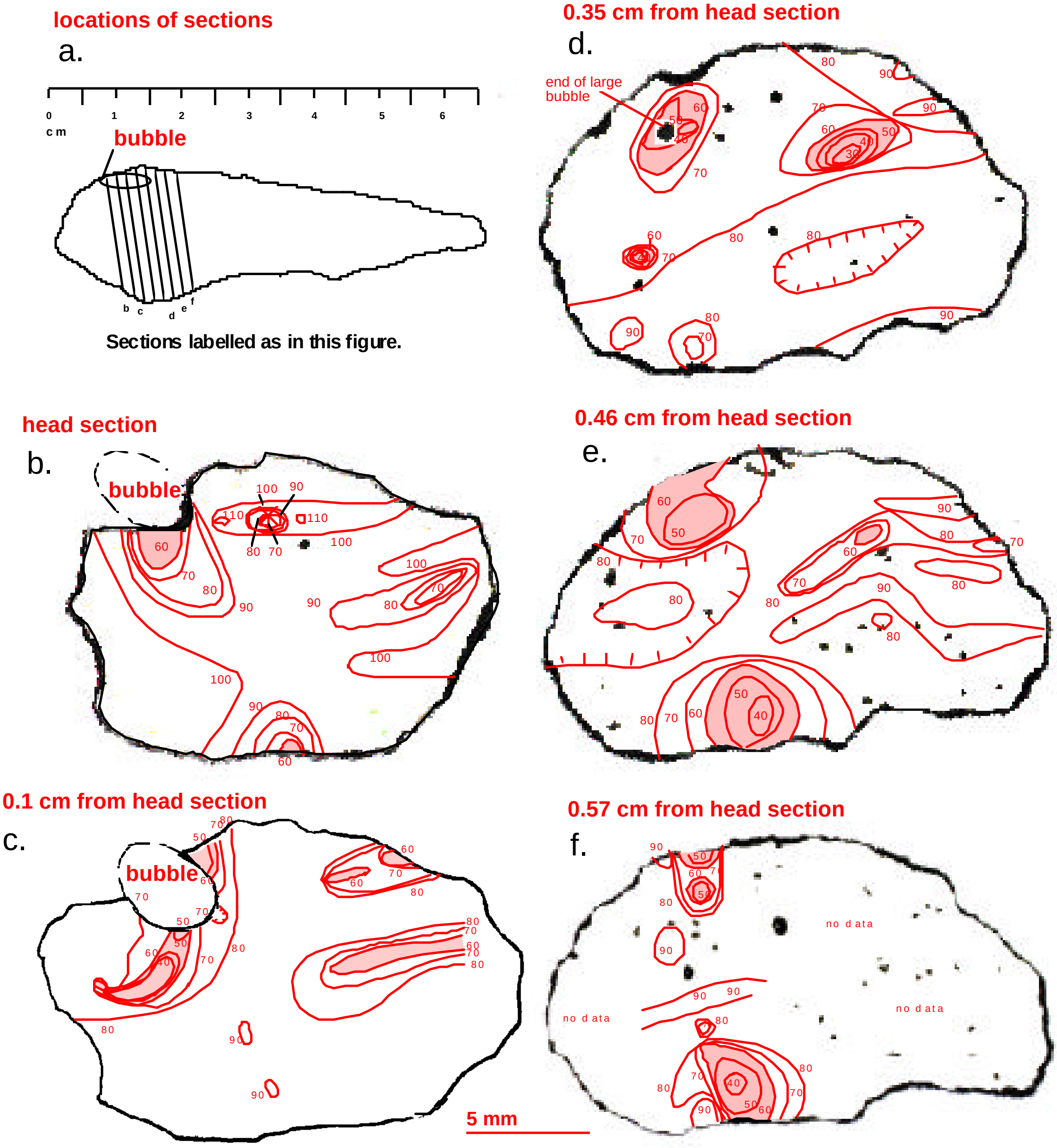
To investigate the possible causes of the variation, we mapped pervasive features in the pattern of water contents, contoured in Fig. 1b–f, especially in comparison with observed physical structures in the glass. Because the technique of FTIR depends on measuring the number of absorbers in a volume, not on a surface, small features such as lechatelierites do not affect water contents, given the thicknesses and spot size involved.

The most obvious physical structure is the large bubble, which originally contained a clay-rich filling. There is a systematic lowering of water content below the average of ~80 ppm to minima of 37–52 ppm in the region of this bubble throughout all five sections (even in the two sections in which the bubble was not physically present). Note, however, that for the two sections in which the bubble passes through the section (Fig. 1b and c), the contours of water content are not concentric with the edge of the bubble. In contrast, the bubble's termination (Fig. 1d) *is* near the water minimum and roughly surrounded by the contours of water content. These features could relate to motion of the bubble relative to the silicate or to bubble coalescence.

Another feature of all sections is prominent flow lines in the upper right quadrant. Although there is a local minimum in water content in this region that is subparallel to the flow lines, other local minima (e.g., lower portion of Fig. 1e) are in areas without prominent flow features.

The overall distribution of water in this indochinite is best described as having broad areas with 80–100 ppm water, on which are superimposed local minima (down to ~30 ppm) in water content with dimensions on the order of 2–3 mm, separated by 3–7 mm. We estimate that, at 2000°C, these features could persist for 2 weeks to 4 months, since the diffusion of hydroxyl groups is so slow in silica-rich melts. It is not clear if these water-poor regions are inherited from the source material of the tektite or if they formed after melting (e.g., by degassing into bubbles, most of which would have to have subsequently escaped from the molten tektite). Hydrogen isotopes could provide a test of the hypothesis that their origin is related to bubble formation.

References: [1] Gilchrist J. et al. (1969) *JGR, 74,* 1475–1483. [2] Koeberl C. and Beran A. (1988) *Proc. LPSC 18th,* 403–408. [3] Newman S. et al. (1995) *LPS XXVI,* 1039. [4] Moore G. et al. (1995) *Geol., 23,* 1099–1102. [5] Zhang Y. et al. (1991) *GCA, 55,* 441–456. [6] Wilding M. et al. (1996) *GCA, 60,* 1099–1103. [7] Newman S. et al. (1986) *Am. Min., 71,* 1527–1541. [8] Dobson P. F. et al. (1989) *GCA, 53,* 2723–2730.



locations of sections

head section

0.1 cm from head section

0.35 cm from head section

0.46 cm from head section

0.57 cm from head section

Fig 1. Sketch (a) of the entire tektite, showing locations of analyzed sections. Contour maps (b–f) of water contents (ppm wt) in the five sections from the indochinite studied here. Section b is closest to the head of the tektite, while section f is closest to the tail. Sections b and c were ~1 mm apart. Two 1-mm sections that were not studied were removed between sections c and d. Sections d–f are each ~1 mm apart. Only three parallel profiles were made on section f, in the region with the contours. At least five profiles covering the entire section were made for each of the other four sections. Shading indicates regions with <60 ppm water. Hatch marks on contours indicate region of lower water content, where this may be ambiguous. 5 mm scale bar at the bottom applies to all sections (b–f).