CHEMICAL SYSTEMATICS AMONG THE MOLDAVITE TEKTITES; J. W. Delano and D. H. Lindsley, Dept. of Earth and Space Sciences, State Univ. of New York, Stony Brook, N. Y. 11794

Introduction

The moldavites were formed 14.8 m.y. ago [1] during the impact event that produced the Ries Crater. These tektites occur in two strewnfields in Czechoslavakia at distances ranging from 260 km to 415 km east of the Ries. Published chemical analyses of moldavites show that a considerable range exists among them (Fig. 1). The chemical variation has been attributed to either fractional vaporization during shock melting [2-4] or mixing between at least two components [4,5]. Investigators who have worked with lunar impact glasses have also invoked similar explanations to interpret the large chemical variations on the Moon. Delano et al. [6] proposed that the complications arising through fractional vaporization during glass-formation could be eliminated from the data by plotting the compositions as ratios of refractory lithophile elements (e.g., Al/Mg; Ca/Ti). The premise was that although fractional vaporization causes changes in the absolute abundances of all elements, the relative proportions (i.e., ratios) of the refractory lithophile elements (e.g., Al, Ti, Mg, Ca, Ba, Sr, REE, Hf, Sc, Ta, U, Th) remain totally unaffected. We have applied this approach to the moldavite tektites.

Results

When two, independent, refractory lithophile ratios are plotted, using the data of [3], the moldavites display a systematic trend (Fig. 2). According to our proposal, this trend is a function only of mixing between at least two components during the melting event. The hyperbolic curve shown in Fig. 2 is NOT a least-squares fit to the data, but rather is a two-component mixing curve calculated using the method of Langmuir et al. [7]. The positions indicated by the tips of the two arrows in Fig. 2 show the end-points used to calculate the curve. The good agreement between this curve and the data indicates that the chemical variation among these tektites (after eliminating all effects due to fractional vaporization) can be understood in terms of mixing between two components. Also shown in Fig. 2, the moldavites and the Ries glasses in the suevite were clearly derived from different source materials. It is generally believed that the glasses at the Ries Crater were produced by impact melting of the granitic basement rocks [4,8,9] located at depths $\geq$ 600 meters in the target, whereas the moldavites may be from the overlying sedimentary rocks [4,5,8]. We propose, in agreement with [5,10], that the source-materials for the moldavites were located within the $\leq$ 50-meter sequence of Tertiary sediments struck by the Ries projectile. In particular, our observations (Fig. 2) suggest that the chemical trend among the moldavites arose through incomplete mixing between two sub-units of those near-surface sediments. The two end-members would have the following characteristics: $CaO/TiO_2 \leq 3.5$, $Al_2O_3/MgO \geq 11.0$; $CaO/TiO_2 \geq 14.0$, $Al_2O_3/MgO \leq 4.5$.

Our suggestion that compositionally distinct units within the target having thicknesses of < 50 meters were "preserved" during an impact event that produced a crater having a transient cavity of about 1500 meters in depth [11] implies that hypersonic flow and ejection of melt during the initial microseconds of the Ries event were orderly.

We expect that further work on tektites and lunar impact glasses will not only provide new constraints on the chemistry of their source-materials but will also make impact glasses, collected by spacecraft from other objects in our solar system, valuable tools of chemical exploration.

References

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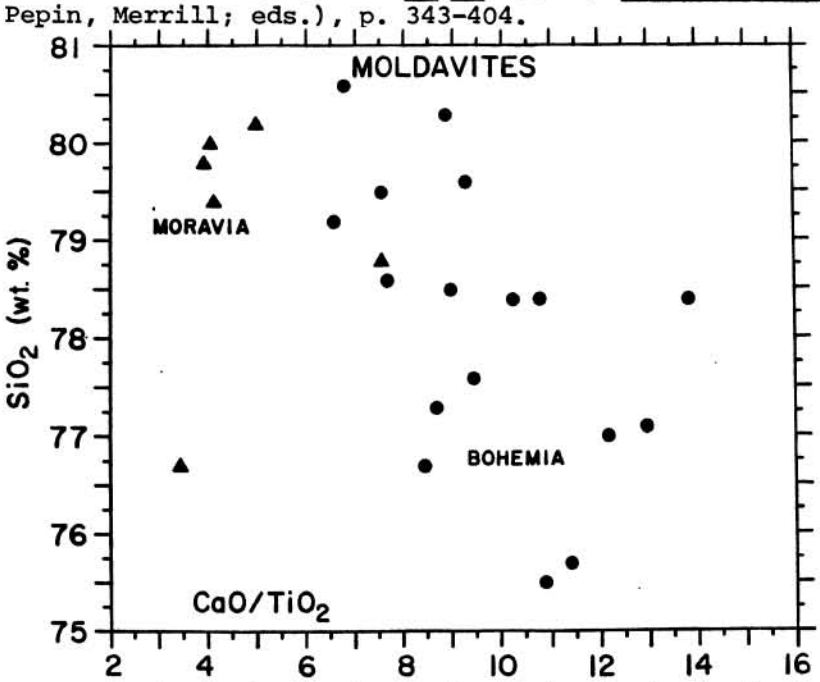

Figure 1. Compositional variation among moldavites from the Moravian (triangles) and Bohemian (circles) strewnfields. Data from [3].

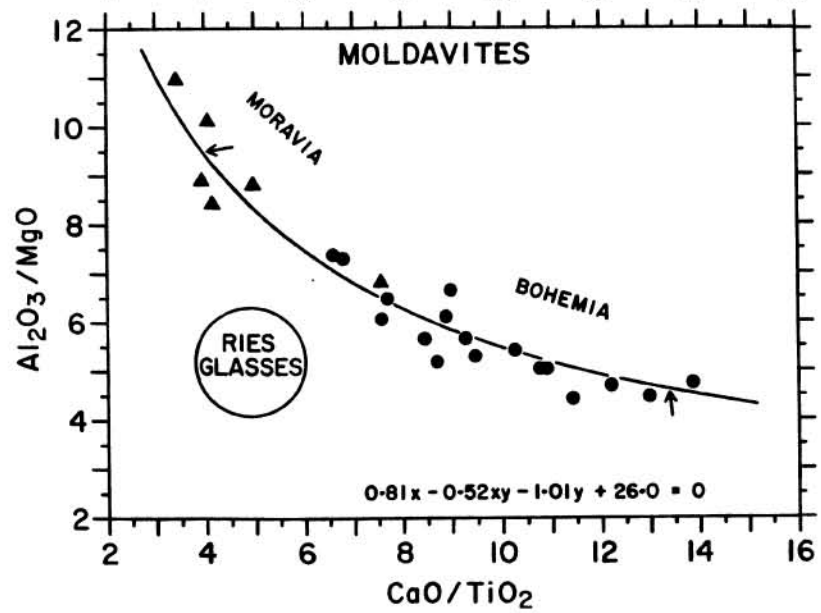

Figure 2. Moldavites [3] and Ries suevite glasses [8,9] were derived from different source-materials. Hyperbolic mixing curve shown and equation provided.