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Sulfide globules in Muong Nong-type tektites from Laos

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1. Introduction

Muong Nong-type (MN-type) Australasian tektites have blocky, layered structures, larger sizes and petrographic evidence indicates a lower temperature origin than envisaged for other tektites [e.g., 1–3]. Their largest known examples are known from Laos, Thailand, Cambodia and the Hainan Island (China) within the Australasian tektite (AAT) strewn field. Microinclusions in tektites may provide invaluable information about the nature of their formation, but can also shed some light on the type of impactor. Coesite, corundum, [e.g., 1, 4] zircon, reidite and ZrO_2 inclusions [e.g., 5] were described from the MN-type tektites. However, as far as we aware, sulfide microinclusions in MN-type tektites have not been observed previously.

2. Materials and methods

Forty-nine polished thin sections from 31 samples of AA tektites sampled in Laos were studied in detail by optical (transmitted and reflected light) and electron microscopy (BSE). Major element compositions of tektites and sulfide inclusions were determined using EPMA. The inclusions were also investigated by Raman microspectroscopy.

3. Results

Rare round-shaped sulfidic spherules with a diameter of ca. <5–20 μm occur in tektite glass domains with numerous small vesicles. Sulfide inclusions were found in several tektite fragments from the same locality possibly belonging to a single larger tektite body. Along the perimeter of the inclusions, there are sometimes cracks but no radial fractures have been observed, whereas within the inclusions, many irregular internal cracks and bubbles occur. The chemical composition of the sulfide blebs is heterogeneous, but their chemical composition determined by EPMA analysis corresponds to phases of Fe-Ni-S ternary system with subordinate amounts of Cu and Co.

4. Discussion

The BSE images reveal that the spherules are inhomogeneous and some display the features, which can be ascribed to the unmixed monosulfide solid solution/intermediate solid solution (Fig. 1). This is confirmed by the different Raman spectra measured at different places within a single spherule. The glass with the direct contact with sulfide blebs is not enriched in any of the elements found in spherules and is chemically identical to the composition of glass more distant from inclusions. In the same samples where the sulfide inclusions were found, the presence of coesite was revealed by Raman microspectroscopy. Coesite as the high-pressure silica polymorph, has been previously reported from AA tektites and microtektites [e.g., 6].

A plausible scenario for the origin of sulfides is that during tektite formation, under high temperature and pressure conditions at extremely low oxygen fugacities (i.e., in highly reducing environment) followed by subsequent rapid cooling, the sulfur-rich droplets of melt were separated from the silicate-rich glass to form an immiscible sulfide melt/liquid that was immediately encapsulated in a silicate glass matrix. Another possible origin of these sulfidic blebs may potentially be tracked back to the sulfidic phases that were originally present in the target materials parental to AAT.

5. Summary and Conclusions

Since these sulfide inclusions are deeply included within the tektite glass, they do not show signs of elemental transfer with the outside environment. Consequently, they can preserve their original

composition reflecting the state at which they were entrapped. The question remains on the origin of the sulfide inclusions. The blebs can be derived from a wide range of the assumed target rocks or can bear an extraterrestrial component of a projectile. Indeed, because the spherules contain Ni and minor amounts of Co and Cu, it is probable that this can be a captured meteoritic component. Resolving of this issue will be the subject of further study.

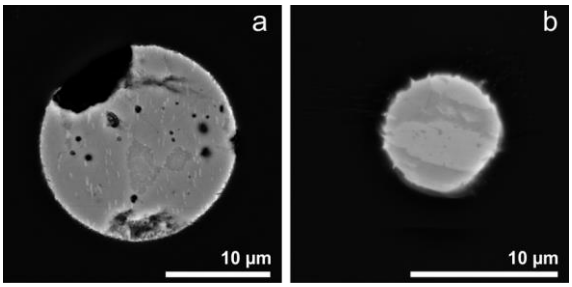

Figure 1: BSE images of typical sulfide blebs hosted by Muong Nong-type AA tektites

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