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Sulfide globules in Muong Nong-type tektites from Laos

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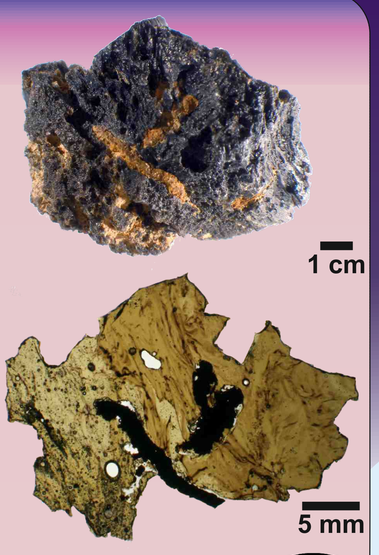
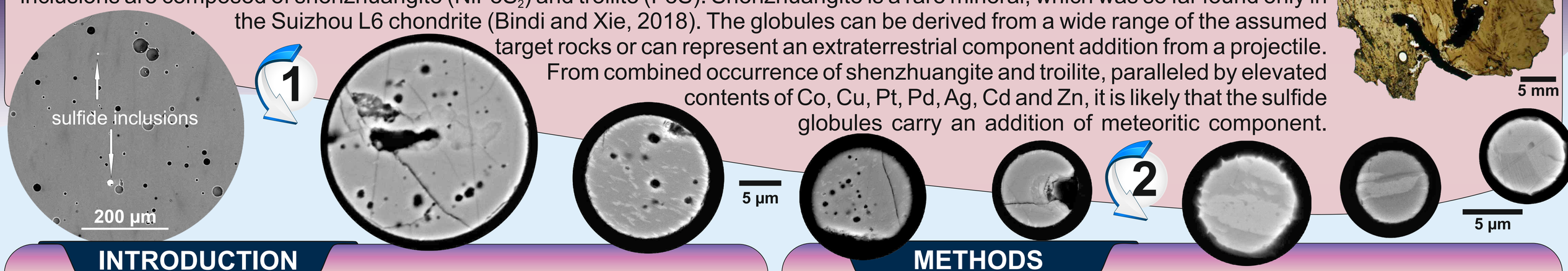
ABSTRACT

For the first time ever, we report sulfide globules in the Muong Nong-type Australasian tektites (AAT) field from Laos. All samples are from the same locality possibly belonging to a single large tektite body. These inclusions were found in all studied samples with the structure of numerous small vesicles. Sulfide inclusions with a diameter <5-20μm occur randomly in part of AA tektites. Detailed identification and mineralogical, petrographic, and chemical characterization of phases in heterogeneous sulfide globules have been performed. The sulfide inclusions can be divided into two groups following the results of combined optical microscopy, BSE, EDS, WDS, EBSD, μ-Raman spectroscopy and LA-ICP-MS analyses.

1 The **Type 1** inclusions are composed of chalcopyrite ($CuFeS_2$), troilite (FeS) and monosulfide solid solution (mss). 2 The **Type 2** inclusions are composed of shenzhuangite ($NiFeS_2$) and troilite (FeS). Shenzhuangite is a rare mineral, which was so far found only in the Suizhou L6 chondrite (Bindi and Xie, 2018). The globules can be derived from a wide range of the assumed target rocks or can represent an extraterrestrial component addition from a projectile. From combined occurrence of shenzhuangite and troilite, paralleled by elevated contents of Co, Cu, Pt, Pd, Ag, Cd and Zn, it is likely that the sulfide globules carry an addition of meteoritic component.





INTRODUCTION

Muong Nong-type (MN-type) Australasian tektites (AAT) have blocky, layered structures, larger sizes and petrographic evidence indicates a lower temperature origin than estimated for other AAT (e.g., Glass and Barlow,1979; Barnes,1989; Koeberl, 1992). Their largest known examples are known from Laos, Thailand, Cambodia and the Hainan Island (China) within the AAT strewn field.

Microinclusions in tektites may provide valuable information about the nature of their formation, but can also shed light on the type of impactor. Coesite, corundum (e.g., Glass and Barlow,1979; Walter, 1965), zircon, reidite and ZrO_2 inclusions (e.g., Cavosie et al., 2018) were described from the MN-type tektites. However, as far as we aware, sulfide microinclusions in MN-type tektites have not been observed previously.

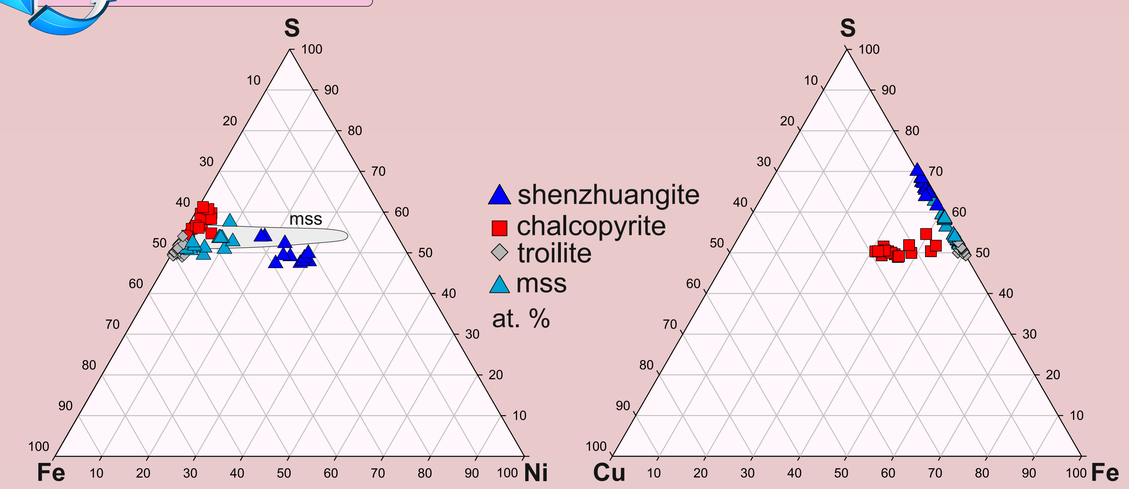
METHODS

- Sampling
- Preparing thin sections
- Optical microscopy observation
- Scanning electron microscopy study (BSE)
- **DISCOVERY OF INCLUSIONS**
- Preliminary chemical analysis using EDS
- Quantitative microprobe analyses using WDS
- EBSD and X-ray mapping
  electron back-scattered diffraction
- micro-Raman spectroscopy
- LA-ICP-MS
  laser ablation inductively coupled plasma mass spectrometry

RESULTS

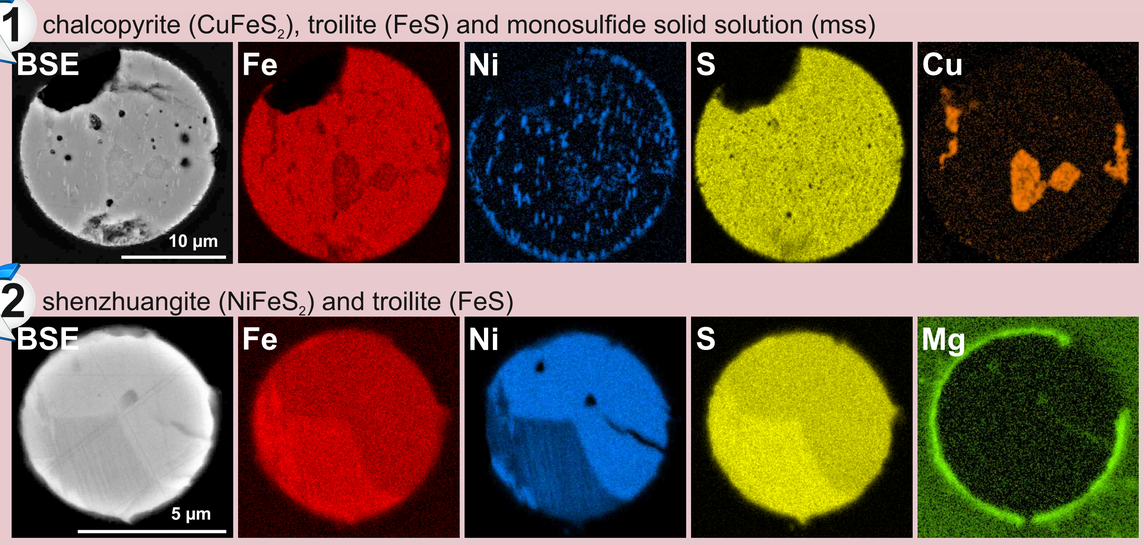
- glass in the direct contact with sulfide globules is not enriched in any of the elements found in globules
- sulfide globules:
  - are deeply embedded within the tektite glass
  - do not show signs of elemental transfer to the ambient glass
  - contain minor amounts of Co, Cu, Pt, Pd, Ag, Cd and Zn

SEM/WDS data



SEM/EDS X-ray maps

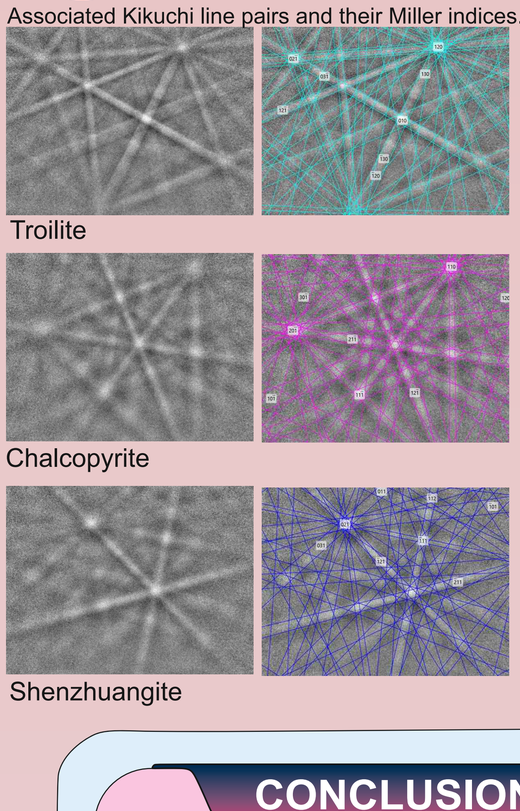
1 chalcopyrite ($CuFeS_2$), troilite (FeS) and monosulfide solid solution (mss)



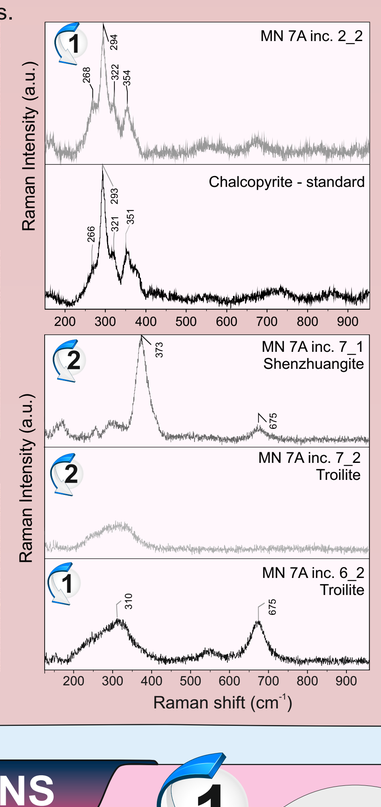
2 shenzhuangite ($NiFeS_2$) and troilite (FeS)

EBSD

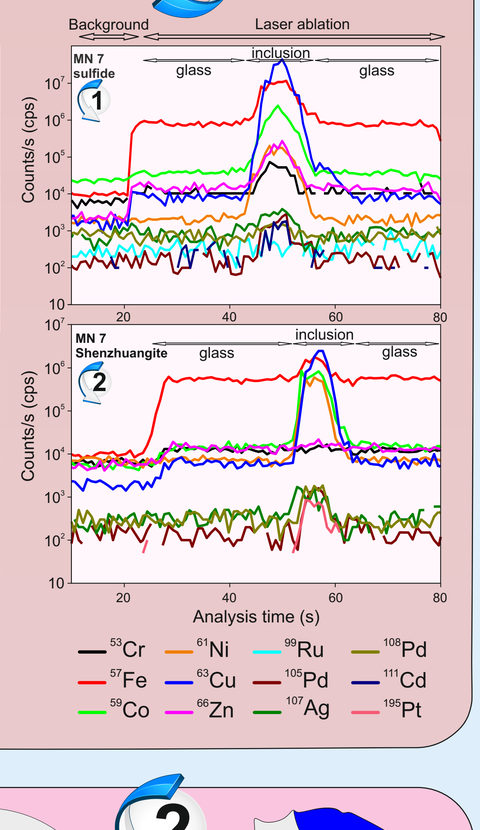
Associated Kikuchi line pairs and their Miller indices.



Raman spectroscopy

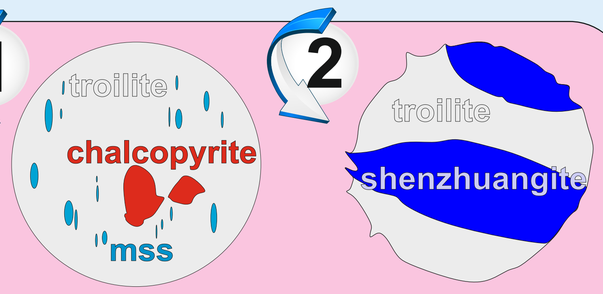


LA-ICP-MS



CONCLUSIONS

- two types of multiphase sulfide globules were found in Muong Nong-type AAT



- a plausible scenario for the origin of sulfides is that, 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 that was immediately encapsulated in a silicate glass matrix
- on the basis of the new results it is likely that sulfides represent a captured extraterrestrial component of a projectile

References

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