CA-PHOSPHATE INCLUSIONS AND PLATINOID RELICT GRAINS IN MUONG-NONG TEKTITES FROM LAOS AND IVORY COAST: IMPLICATIONS FOR THE AUSTRALASIAN IMPACT.

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Introduction: Tektites are small (cm-sized) reduced glasses of Earth's surface material that have been melted and ejected by a meteorite impact [1,2]. Tektites occur in five widely dispersed "strewn fields". The Australasian strewn field is the youngest (789 ± 9 ka [3]) and the largest, covering over 15% of the surface of the globe [4], yet it remains the only one without a clearly identified source crater [5,6]. The vast majority of tektites are homogeneous glasses, but proximal layered samples, also known as Muong Nong Australasian tektites (MN-AAT), often preserve mineral inclusions that are a rich source of information, providing new insights into the source material, the thermal history of the sample, and the tektite formation process.

Methods and samples: we collected numerous MN-AAT samples in the vicinity of Muong Nong (Laos) and investigated systematically their magnetic susceptibility. One sample, 8 times more magnetic than the average MN-AAT revealed the presence of Ca-phosphate inclusions in the host glass and motivated in-depth investigations using correlative microscopy. This study combined the analyses from scanning optical microscopy, electron microscopy (SEM) and, scanning/ transmission electron microscopy (S/TEM) using a JEOL JSM-IT800SHL Field Emission Gun (FEG) SEM at the Hubert Curien laboratory in Saint-Etienne (France) and a 200 kV NeoARM200F STEM handled by the CLYM consortium in Lyon. The composition and Fe oxidation state were determined using X-ray energy dispersive spectroscopy (EDS) and electron energy loss spectroscopy (EELS). A layered MN-like Ivory Coast tektite (ICT), 2.3 times less magnetic than the average and bearing homogeneous Ca-phosphate inclusions, was studied for comparison as its source material is well known [7].

Results: In the MN-AAT, inclusions consist mostly of lechatelierite domains (pure SiO_2) and single droplets of apatite. However, within flow bands, emulsions of partially coalesced spherules (10 µm) show a complex assemblage of apatite, magnetite, pyroxene, and dendritic spinel growing from a platinoid grain as a nucleus. Spinels show a variation in composition accompanied by a $Fe^{3+}/\Sigma Fe$ decrease, with an Fe-rich core crystallizing from the Pt-rich nuclei to an Al-rich termination. The platinoid grain is a single crystal and exhibit a low Ir content, but relatively a high Ru and Rh concentration (normalized to Ir and chondrites: X/Ir/CI/Ir; Os:0.32, Ir:1.00, Rh: 4.73, Pt: 2.62, Rh: 4.36, Pd: 0.00). This composition differs from the average compositions of meteoritic refractory metal nuggets. Ultimately, diffusion profiles and viscosity ratio between the lechatelierite domains and the host glass reveal high maximum temperatures (>2200-2400°C) and a short heating time on the order of seconds rather than minutes [8]. The number, density and complete recrystallisation of the inclusions, indicate relatively slow cooling rates (<200°C/h).

Discussion: Partially coalesced spherules suggests immiscible liquids of molten detrital grains and show that, although heated to high temperature (>2200°C), the MN-AAT did not remain in the vapor plume for a long time (few seconds) allowing the quenching of the emulsion texture and the preservation of the phosphate inclusions. The material landed quickly (after a few tens of seconds), at a high temperature (>1000°C) where it spread out and cooled, giving its characteristic layered texture to the tektite. The investigation of the source material of the iron-poor MN-ICT is an interesting point of comparison, in the search for the origin of phosphate inclusions. The low phosphorus concentration in the target sediment suggests that the parent material of these phosphate-rich inclusions could be inherited from a more superficial source such as a tropical soil (source of phosphorus) and its biomass. The reduction process that tektites record during their formation may thus be explained by the sizable mass of carbon that forests can contain and that can reduce iron in tektites and produce the $Fe^{3+}/\Sigma Fe$ gradient recorded in the MN-AAT. Ultimately, we foresee that the composition of those PGE determined by a more precise method like atom probe tomography may prove useful in the quest to identify the target of the Australasian impact.

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