

Ambient inclusion trails (AITs) in the Ediacaran Doushantuo Formation, south China: New observations and a refined model

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Ambient inclusion trails (AITs) in association with pyrite are interesting microtubular structures that commonly occur in Precambrian fossiliferous chert or phosphorites. They are generally attributed to the migration of pyrite crystals through a lithified substrate driven by the decomposition of organic matter, yet the detailed mechanism remains elusive. Two distinct types of AITs are described in the phosphorites of the Doushantuo Formation in the Baizhu section, Baokang City, South China. AITs in granular phosphorites are relatively large and abundant, with widths ranging from 8.5 to 68 μm , whereas AITs in laminated carbonaceous phosphorites are only 1.6 to 9.7 μm wide. Both types of AITs are often observed with terminal minerals such as pyrite and fine longitudinal striations along their inner walls. The spacings of the longitudinal striations in the smaller AITs are 0.3 to 1.8 μm , similar to the diameters of micro-crystals (0.2 - 1.4 μm) in co-existing pyrite framboids. The pyrite framboids, ranging in sizes from 1 to 12 μm , are considered as terminal grains of these small AITs. These observations suggest that some of the small AITs might have formed by the migration of pyrite framboids during syngenetic stage, rather than during diagenetic stage as previously proposed. Raman microspectroscopy, transmitted electron microscopy and Nano-SIMS elemental mapping show that carbonaceous microfossils and nanoscopic particles are embedded in the apatite groundmass, part of which could have decomposed through bacterial sulfate reduction and provided abundant CO_2 and H_2S gases. The latter, combined with ferrous iron, produced pyrite framboids which were driven by the gases and led to the formation of AITs.