

Mineralogical study of a stalagmite in Goa Asrep cave, Central Java

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[Introduction]

Stalactites in caves are the secondary deposits consist of calcite crystals. Recently, stalactites have been used as a new tool of the paleoclimate reconstruction, because it continuously grow for the period of about 100,000 years on the continental areas different from ice core or marine core (Fairchild et al, 2006). Periodic bands observed in stalactites have been treated as 'annual bands'. However, the study of the internal textures of stalactites is few (Frisia et al, 2000, 2002). A mineralogical study was carried out on the internal texture of the stalactite (stalagmite) collected in the Goa Asrep cave, Central Java in the present study.

[Classification of zones]

The stalagmite ASR07 can be classified into two types of zones, based on the aggregation schemes of calcite crystals.

1. Parallel growth zone (PGZ): The zone consists of calcite crystals in elongated shapes along their c-axes and the axes are almost parallel to each other and to the growth direction of the stalagmite.
2. Polycrystalline zone (PCZ): The zone is characterized by the aggregates of calcite crystals in small size. The c-axes of the crystals are randomly arranged.

[Formation conditions of two types of zones]

The formation conditions of two zones can be estimated from the relative rates of the nucleation and growth processes. In PCZ, the number of crystals increases abruptly when the zone starts at the boundaries from PGZ to PCZ, suggesting a predominant nucleation process. On the other hand, the number of crystals does not change so much, except for the transition zones from PCZ to PGZ. This suggests that the formation of PGZ is controlled mainly by a growth process.

The decrease of the number of crystals and the completing of the parallel growth observed in an early stage of the formation of PGZ can be well-explained by "geometrical selection". During the process of geometrical selection, radially grown crystals are also observed occasionally.

[Characteristics of bands in zones]

Opaque bands about 500um in thickness observed at the boundaries between zones and in PCZ consist of voids and small grains of pyroxene and feldspar (which have a volcano origin) in addition to tiny grains of calcite. The growth direction of the stalagmite changes through these bands.

Bands appears as inhomogeneity within crystals. These bands can be classified into two categories : periodic and single pulse like.

A. Periodic band: This bands which appears as rows of pores in thin section have been treated as 'annual bands'. These pores may be formed by dissolution of unknown materials during the

preparation of thin sections.

B. Single pulse like band :Two types of single pulse like bands are observed as follows.

B-1. Zig-zag band: The bands are characterized by zig-zag lines. Each segment of the bands is considered to be traces of an euhedral shape of calcite.

B-2. Smooth band: This type of the bands are smoothly curved, suggesting that a dissolution process is responsible for the smoothness.

[Conclusion]

The stalagmite ASR07 collected in Goa Asrep cave, Central Java can be classified into two zones ; Polycrystalline zone and Parallel growth zone, based on the aggregation schemes of calcite crystals. Fine band structures observed within two zones. These bands in PGZ can be classified into two categories : periodic ('annual bands') and single pulse like (zig-zag and smooth bands). The internal texture of the present stalagmite can be explained by the overlapping of three types of changes in the formation conditions :

- (1) relatively large change in s resulting in the formation of two types of zones,
- (2) abrupt change like a single pulse appeared as fine bands in each zone and
- (3) annual change under near steady state conditions.

It is worthy to note here that the former two types of the changes imply the abrupt and drastic changes in environment around the cave.

Keywords: stalactite, stalagmite, geometrical selection, degree of supersaturation