

## Geomorphological Factors Affecting Speleothem Distribution in the Abukuma Cave, Japan: A 3-D Laser Scanning Approach

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A terrestrial 3D laser scanner (TLS) is useful to obtain high resolution data of landforms. Recently TLS surveys have often been conducted to measure and analyze landforms particularly in Europe and North America, but have been relatively limited in Japan. This study aims to measure detailed topography of a limestone cave including speleothems using a TLS and analyze the relationship between speleothem distribution and morphological characteristics of surrounding ceilings. The study site is the Abukuma Cave in Tamura City, Fukushima Prefecture in central-northern Japan. We use a TLS of TOPCON Co. (GLS-1500) to obtain 3D point cloud data in a 29-m high space called Takine-goten. Analyses of the edited 3D point cloud, including a point dataset of stalactites and a 5-cm resolution DEM, were performed to assess the effects of slope and curvature of the ceiling surface on the distribution of stalactites. As a general trend, stalactites tend to occur at places with intermediate slopes, high standard deviations of slope and high absolute values of curvature. As a local analysis, the Takine-goten was divided into three areas in an outlet to inlet direction. Different characteristics of stalactite distribution and forms are found in each area. Stalactites are frequently found near the outlet where abundant water sprays out from the bedrock, despite low standard deviations of slope and low absolute values of curvature. Some stalactites in the innermost area are found in places with low standard deviations of slope and high absolute values of curvature, indicating that stalactites tend to occur in places where slope changes within a small area.

Keywords: Terrestrial 3D laser scanner, Speleothem, Geomorphological factors, Abukuma cave, Stalactite