地震時の崩壊発生場を規制するテフラ層序とハロイサイトの生成過程：2016年熊本地震により発生したテフラ斜面の崩壊を例に

Tephrostratigraphy and the formative processes of halloysite that controll landslide sites by earthquakes: Landslides of tephra induced by 2016 Kumamoto earthquake

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2016 Mjma 7.3 Kumamoto earthquake induced numerous numbers of landslides and caused heavy damage in the Aso Caldera and nearby areas. We made airphoto interpretation, field survey, and analyses on mineralogical and physical properties. We identified over 400 landslides of tephra in the Aso Caldera, of which we investigated 63 landslide in the field and identified stratigraphic horizons of their sliding surfaces and examined the mineralogy of involved pyroclastic fall deposits. Many of the landslides occurred on slopes with 20° to 30° inclination and their depths were mostly 2-8 m and up to 14 m. Twenty-one landslides had their sliding surfaces in andosol, 20 in Kusasenrigahama pumice (Kpfa), and 10 in brownish volcanic soil containing acidic lava blocks; these landslides altogether occupied 51 in 63 landslides investigated. Other landslides had their sliding surfaces in the mixture of andosol and brownish volcanic soil (5), scoria (2), hydrothermal alteration clay (2), pumice older than Kpfa (1), and sandy ash (1). We identified the stratigraphic horizons of these tephra beds that accommodated sliding surface. The andosol that accommodated sliding surfaces were near the horizon of Kikai-Akahoya tephra (7.3 ka). Another sliding-surface accomodating Kpfa was of 30 ka. Materials that contain sliding surface were dominated by halloysite except for the landslides of hydrothermal alteration clay. Halloysite, which is very susceptible to earthquake shaking, was made in andosol deeper than 2 m probably by resilication of the material by percolating water through the overlying volcanic soil. Probable resilication and the halloysite formation in the pumice layer occurred from its top when it is directly covered with brownish volcanic soil because of Si in the percolating water through it. On the other hand, when the pumice layer is covered by andosol instead of brownish volcanic soil, halloysite formation from the top does not occur because Si from the shallow portion is consumed in the overlying andosol. Instead, it is inferred that chemical leaching occurs in the upper portion of a pumice bed and resilciation occurs at its base and the top of the underlying volcanic soil. The stratigraphic horizons of the sliding surface and the halloysite formative processes stated above give us a clue to identify areas which are susceptible to earthquake shaking.

キーワード：地すべり、崩壊、2017年熊本地震、テフラ、ハロイサイト
Keywords: landslide, debris avalanches, 2016 Kymamoto earthquake, tephra, halloysite