



Unusual gravitational failures on lava domes of Tatun Volcanic Group, Northern Taiwan.

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Tatun Volcanic Group of Northern Taiwan was formed mainly during the Pleistocene - Early Holocene. Most of the volcanoes are represented by andesitic lava domes of moderate sizes: heights up to 400 m (absolute altitudes 800-1100 m a.s.l.), base diameters up to 2 km, and volumes up to 0.3 km³. Many of the domes have broadly opened (0.5-1.0 km across and up to 140° wide), shallow-incised horseshoe-shaped scars formed by gravitational collapses. The failure planes did not intersect the volcanic conduits, and the scars were not filled by younger volcanic edifices: most of the collapses occurred a long time after the eruptions had ceased.

The largest collapse, with a volume 0.1 km³, occurred at eastern part of Datun lava dome. Specific feature of the collapse was that the rear slide blocks did not travel far from the source; they stopped high inside the collapse scar, forming multiple narrow torelva blocks descending downslope. The leading slide blocks formed a low mobile debris avalanche (L~5 km; H~1 km; H/L~0.2). The deposit is composed mainly of block facies. The age of the collapse is older than 24,000 yrs, because the related debris avalanche deposit is covered by a younger debris avalanche deposit of Siaoguanyin volcano having calibrated 14C age 22,600-23,780 BP.

The Siaoguanyin debris avalanche was formed as a result of collapse of southern part of a small flank dome. Specific feature of the resulted avalanche - it was hot during deposition. The deposit contains carbonized wood; andesite boulders within the deposit frequently have radial cooling joints, and in rare cases "bread-crust" surfaces. The paucity of fine fractions in the deposit can be connected with elutriation of fines into the convective cloud when the hot avalanche travelled downslope. However in several locations the deposit is represented by typical avalanche blocks surrounded by heterolithic mixed facies containing abundant clasts of Miocene sandstone (picked up from the substrate). Thus the deposit bears features of both debris avalanches and lithic-rich block-and-ash flows. The avalanche was rather mobile (L~6 km; H~1 km; H/L~0.16), despite its small volume (0.02 km³). Its speed reached 40 m/s at a distance of 5 km from the source (based on 80 m high runup of the avalanche). The characteristics of the avalanche deposit indicate that crystallized, degassed, but still hot material of a newly extruded lava dome was involved in the collapse.

Unusual low mobile debris avalanche was formed as a result of collapse of western slope of Mt. Cising. A former lava coulee, which was involved in the collapse, underwent only weak disintegration: debris avalanche deposit is represented by big boulders with few fine grained matrix. Leading snout of the landslide traveled only 2 km, while rear slide blocks stopped near the landslide source forming multiple narrow torelva blocks descending downslope. Volume of the collapse 0.05 km³; maximum dropped height 0.5 km, H/L 0.25. Around the distal snout of the avalanche a "bulldozer facies" is well developed. Dating of vegetation entrained into the deposit gave 14C calibrated age 6000-6080 BP.

Mobility of the studied debris avalanches was twice smaller than the average mobility of volcanic debris avalanches. Relatively small volume of the collapses, the particular type of material involved (massive lava domes) and the fact that the collapses occurred long after the volcanoes stopped erupting may have played a role in the low mobility of the debris avalanches of the Tatun Group.