

Emplacement and growth of the Tottabetsu plutonic complex, north Japan: inference on the 3D shape of the pluton

Hiroyuki Kamiyama[1]; Akihiko Yamamoto[2]; Takanori Kajiwarra[3]; Takashi Nakajima[4]; Toru Mogi[1]

[1] ISV, Hokkaido Univ.; [2] Institute of Seismology and Volcanology, Hokkaido Univ.; [3] Earth Sci., Hokkaido Univ; [4] GSJ

Construction of plutons is a multi-stage and multi-process geological event including emplacement, growth and solidification of magma bodies within the Earth's crust. Important information on the mechanism by which plutons are constructed is preserved in their shapes and internal structures. However, exposures of the overwhelming majority of plutons only provide subhorizontal sections, so information on the vertical variations in shape, lithology and internal structures is severely limited. An exposed cross section of the Tertiary Tottabetsu plutonic complex reveals not only its two-dimensional shape with the vertical dimension, but also a magmatic stratigraphy that can be used to develop a history of pluton construction. The pluton has a rectangular cross-sectional shape with pre-tilting vertical dimension slightly greater than horizontal one (10km thick and 8km wide). It is compositionally stratified, consisting of a thin granitic unit (1-1.5km thick) at the top and the underlying thick gabbro-diorite units (~9km thick). Alternation of variably chilled gabbroic and dioritic sheets and gabbroic and dioritic cumulate layers in the gabbro-diorite units suggest that these units were sequentially formed from below at the aggrading floor of the magma chamber by cumulate accretion and vertical stacking of successive hotter injections. Initial Sr isotopic ratios of the granites are similar to those of the gabbros and diorites, indicating that the thin granitic unit at the top of the complex represents the complementary fractionates to the cumulate materials in the gabbro-diorite units. Because the pluton thickened gradually by simultaneous crystallization and replenishments, active magma chamber at any one time must have been much thinner than the entire complex. Attitudes of the paleohorizontals (i.e. floor of the magma chamber at any one time) inferred from the sheets, pipes and cumulate layering and foliation are nearly constant, roughly perpendicular to the original side walls and subparallel to the original roof of the pluton. This, together with the rectangular cross-sectional shape, led us to suggest that space for the successive batches of injected magmas was created by vertical displacement of the fault-bounded blocks of roof or floor country rocks with little horizontal displacement. The piston model proposed here for the mechanism of space creation predicts that the pluton is cylindrical in three-dimensional shape. We will also present new gravity data and discuss the subsurface shape and mass distribution of the pluton.