

Variation of the average aspect ratio of plagioclase in the Atsumi dolerite sills, Northern Japan

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To clarify the time scale of cooling and crystallization of magma in igneous rocks is important for determining the time scale of magma processes. According to experimental studies of plagioclase, it is shown that increasing undercoolings and cooling rates result in greater differences between the growth rates of the different crystallographic faces, resulting in grains which are elongate parallel to [100] (Muncill and Lasaga, 1988; Pupier et al., 2008). Recently, Holness (2014) found that there is a good correlation between the average aspect ratio and the crystallization time in six sills which have relatively similar compositions and different thicknesses and showed that the aspect ratio is useful as a speedometer in igneous intrusive bodies. In this paper, it is concluded that the shape of plagioclase is relatively insensitive to small variations of magma composition, but the influence of magma composition on the aspect ratio is not discussed in much detail. Therefore, in order to examine the influence of magma composition on the aspect ratio, we conducted the measurement of the plagioclase aspect ratio and the calculation of the crystallization time for two alkaline basaltic sills in the Atsumi district (Kayaoka sheet, 120 m in thick; an intrusive body in Hakuzan island, 6 m in thick; Kushiro 1964).

As a result, the following results were obtained for plagioclase from the two sills: (1) The ranges of the average aspect ratios (major axis length / minor axis length) are about 3.8-5.6 and 6.4-9.8 for the Kayaoka sheet and the intrusive body in Hakuzan island, respectively. (2) There is a negative correlation between the average aspect ratios and the calculated crystallization times in the two sills. (3) In the Kayaoka sheet, the average aspect ratio increases from the central part towards the top and bottom but decreases again only in the undermost few meters (Fig.1; S-shaped profile). The features of (2) and (3) are the same as those reported in Holness (2014). However, compared between sills of comparable thickness, average aspect ratios in our study are significantly larger than those in Holness (2014) (for example, the average aspect ratio in the 129-meter-thick Whin sill is about 3.0 - 3.6). The differences in plagioclase aspect ratio are likely to be caused by the influence of magma viscosity on diffusion coefficient.

Keywords: aspect ratio, cooling rate, Atsumi dolerite

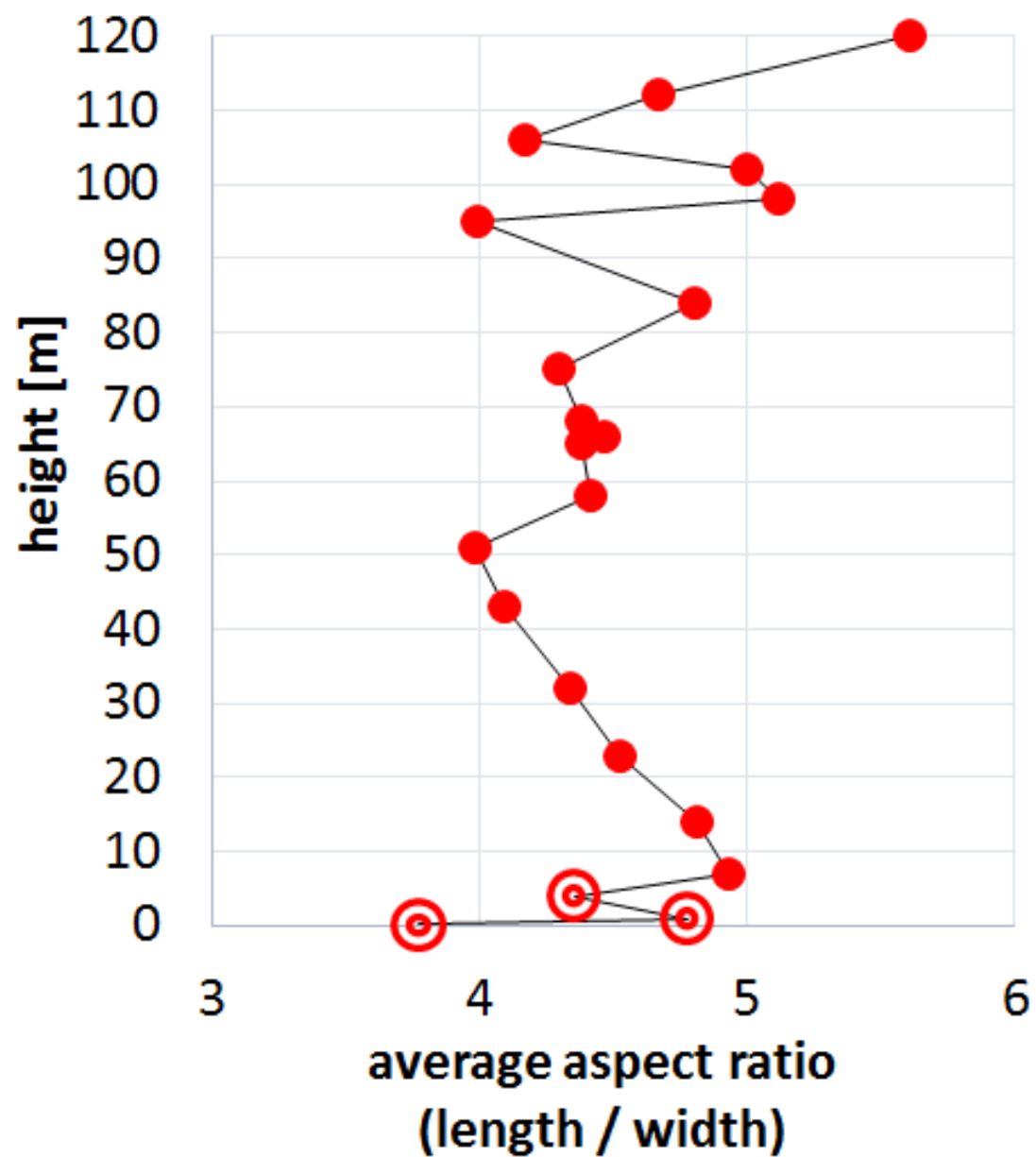


Fig.1 Stratigraphic variation of plagioclase average aspect ratio in the Kayaoka dolerite sheet.