W214-P002 Room: Poster Session Hall Time: May 15

Anisotropic distribution of ice crystal orientation in the deep part of ice sheets and stability of ice sheet flow

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In recent years, deep ice coring projects are furthered by world nations in the Antarctica and Greenland. They got the old ice which is expected to go back to million years ago from the deep part of ice sheet. Although ice masses in the deep part of ice sheets are carrying out the most of deformation of the whole ice sheet, since there are a few deep cores, the details of internal structure and flow characteristics are not clear. In addition, it depends on model calculation concerning the dating of the deep core. Then, it is important that detail internal structure of ice sheet in the deep section is revealed. In this research, crystal orientation analysis and the simple shear test which are observed to the especially a-axes orientation of the typical deep ice sheet core in the north and south both ice sheets are done, and flow characteristics is argued. The samples cut from the deep ice cores from the GRIP and the Dome Fuji, which were drilled at top of dome position of the Greenland and the Antarctic ice sheet.

The fabric pattern of c-axis orientation have shown weak single maximum to strong single maximum with depth by former researches. Furthermore, we did the crystal orientation analysis by using X-ray Laue method. We found that the anisotropic distribution of a-axes which is align in the same direction. In order to understand the mechanism of anisotropic distribution of a-axes orientation, simple shear tests were carried out on the GRIP ice core. The anisotropic distribution of a-axes is verified partly, therefore it is expected that they develop by undergoing simple shear deformation with the migration of dome position. The result of simple shear tests shows that the direction difference of a-axis between adjacent grains becomes small in less than 10% strain. In more than 10% strain, the direction of [11-20] of each crystal tends to align to shearing direction. On the other hand, c-axis orientation distribution shows strong single maximum in the deep part of ice sheet. It became clear that deformation rate changes approximately 2 times by the difference in very slight degree of c-axis concentration. In the section of strong single maximum, these ice masses flows easily very much in horizontal direction. In this region, if a-axes align to the same direction, crystal texture close to monocrystal. It is suggested that flow velocity becomes faster, but the quantitative influence is unclear, because it is impossible to make quantitative analysis for concentration ratio of a-axes now. We have shown the fact that the ice body flows very easily in deep section. It means that the enormous ice masses in the Antarctica and Greenland exist on the very unstable pedestal. As for this, if mass balance of the ice sheet deteriorates by global warming, the ice sheet has the possibility to change greatly.