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PERMAFROST OCCURRENCE AT ICE-FREE GROUND IN JAMES ROSS AND SEYMOUR ISLANDS, ANTARCTIC PENINSULA AREA (ABSTRACT)

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The Japan-Argentina joint expedition was established by the support of Grant-in-Aid for Overseas Scientific Research from the Ministry of Education, Science and Culture, Japan. The authors conducted the field survey related to the genesis and occurrence of permafrost in James Ross Island and Seymour Island, in the east of the Antarctic Peninsula, during the 1989–1990 Antarctic summer season. The climatic condition of the area with mean annual temperature of −10°C is favorable to the existence of permafrost if the ground surface is not overlain by the glaciers for certain periods of time.

In James Ross Island, more than 90% of the ground surface is covered with the glaciers and ice-sheets. The ice-free ground is narrowly distributed in the north western region along Croft Bay. In this region, marine terraces at three different levels are observed with the elevations of 32–35 m a.s.l. at upper level, 10–17 m a.s.l. at middle level and 3–5 m at the lowest level. Aiming to obtain the chronological information of terraces, detailed topographic mapping and stratigraphic survey were conducted on-the-spot. According to the results of survey, the glacial till deposited on the subsurface layer of the highest terrace indicates the coverage of glaciers over this terrace. No glacial tills were observed on the surface of both middle and lowest terraces. It implies that the glaciers had retreated before the formations of these lower terraces and the physical conditions were favorable to the development of permafrost. Sea shell specimens collected from the layers constituting the middle terrace indicate that the ground surface of the middle terrace was submerged under the sea level. Once the ground surface submerges under the sea level, the surface of the ground is subjected to the warmer boundary temperature than that enables permafrost to exist. No permafrost develops in the underlying sediments, or a pre-existed permafrost may have diminished under these environments.

Then the submerged ground is upheaved above the sea level to form marine terraces and is exposed again to severe climate condition to develop permafrost. Thus the absolute ages of sea shells measured by means of ^{14}C dating indicate the year of initiation of the permafrost growth on the marine terraces. We obtained two different years of ^{14}C dating; 25000 B.P.Y. for the middle terrace and 3000 B.P.Y. for the lowest terrace. Based on these values, one can conclude that permafrost on the highest terrace began to form prior to the last maximum glacial epoch. The depths of lower boundary of permafrost on the middle and the lowest terraces were estimated by means of geo-electric resistivity survey with the values of 40 m and 3–5 m, respectively. If one compares these values of depths with those in the Arctic regions under similar present climatic conditions, he easily finds the shallower permafrost develops in the Antarctic regions than in the Arctic regions. These differences are mainly due to the submergence of the ground under sea level during the postglacial periods in the Antarctic regions.

Similarly the marine terraces at three different levels are distributed in the northern part of Seymour Island, which is 80 km away from James Ross Island to the south. On the lowest terrace, the depth of lower boundary of permafrost was estimated at 28 m based upon the results of geo-electric resistivity survey. Long-term temperature fluctuations at different depths in permafrost on the lowest terrace were collected using data logging systems which had been installed in 1987 during the session of the previous expedition. The mean annual temperatures of the ground at various depths were calculated from read-out of the records. The temperature gradient of permafrost in steady state was estimated. Then the extrapolated line of the gradient to the lower layers in permafrost meets with zero degree C at the depth of 30 m indicating the lower boundary of permafrost. This value coincides with the one estimated by geo-electric resistivity survey. The organic materials from the subsurface layer on the lowest terrace were sampled and subjected to ^{14}C dating. The dated value of 3000 B.P.Y. suggests the age of initiation of ground upheaval above the sea level and initiation of permafrost growth. The general tendency of shallower permafrost in the Antarctic regions than in Arctic regions is concluded with relation to the sequential change of submergence and succeeding upheaval of the ground.

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