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Distribution of Sr isotope ratios in the vegetation of Siberian dwarf pine at Mt. Tateyama

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Chubu-Sangaku mountainous area in central Japan is composed of mountains whose elevation is over 2500 m above sea level (a.s.l.). In the soil of this high elevation area, biological activity is inactive due to low air temperature and long snow cover, resulting in the slow decay of biomass, immobilization of nutrient, and depressing the material circulation. Wet and dry depositions in these mountainous ecosystems play an important role as nutrient supply. Wet precipitation on the forest ecological system partly adheres on leaves and branches, and water returns to the atmosphere by evaporation. The chemical composition of throughfall changes from the precipitation by interaction with tree and grass. Some elements are absorbed from crown. Further high elevation area is sensitive to materials transported from regional air pollution. However, there are a few geochemical and material-circulation studies on the mountainous ecosystem with high elevation. We have been studied ecological and plant physiological studies on Mt. Tateyama, one representative Ch?bu-Sangaku mountainous area. The ecological system of Mt. Tateyama is important, since this mountain is strongly impacted from air-pollutants from the Asian continen as it faces the Sea of Japan, and is affected by global warming as the air temperature increases more than three times as the world average during recent 30 years.

Sr is known as a powerful hydrological and ecological tracer but it is utilized as a fingerprint to understand plant physiology. This isotope is unique as it can quantitatively discriminate atmosphere-derived Sr from bedrock-derived Sr. In order to elucidate the material circulation system on the forest ecosystem in Tateyama, we sampled a variety of water (rainfall, throughfall, fog water, snow, groundwater, and dale water) and Siberian dwarf pine in Joudodaira, and determined their Sr isotope ratios. Our result shows that the $^{87}Sr/^{86}Sr$ ratio of groundwater (0.7068) and dale water (0.7070) are almost identical to that of soil and bed rock (0.7070), suggesting that Sr in the surface and ground water is largely derived bedrock through chemical weathering. This is consistent with that rainwater (0.7091) and fogwater (0.7090) have higher $^{87}Sr/^{86}Sr$ ratios. As this ratio is similar to seawater value (0.7092), Sr in precipitation is largely of sea-salt origin. It is notable that the $^{87}Sr/^{86}Sr$ ratio of dirty materials in snow is variable from 0.7095 to 0.7198. This high ratio suggests an incorporation of Asian dust particle whose $^{87}Sr/^{86}Sr$ ratio is around 0.720. The 87Sr/86Sr ratio of throughfall is 0.7094, indicating a contribution Asian dust Sr. The most notable feature is that Siberian dwarf pine (Pinus pumila) has high $^{87}Sr/^{86}Sr$ ratios (0.7099 in leaf and branch and 0.7097 in litter). Most alpine plants have lower $^{87}Sr/^{86}Sr$ ratios (0.707 of Gaultheria miqueliana and 0.708-0.7095 of others). This result demonstrates that Siberian dwarf pine is actively absorbing Asian dust particles.

Keywords: Asian dust, Pinus pumila, plant ecophysiology, Sr isotope, Alpine, Forest hydrology