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Studying of tritium content in snowpack of Degelen mountain range

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ABSTRACT

The paper presents the results of investigation of tritium content in the layers of snow located in the streambeds of the "Degelen" massif contaminated with tritium. The objects of investigation were selected watercourses Karabulak, Uzynbulak, Aktybai located beyond the "Degelen" site. We studied the spatial distribution of tritium relative to the streambed of watercourses and defined the borders of the snow cover contamination. In the centre of the creek watercourses the snow contamination in the surface layer is as high as 40 000 Bq/L. The values of the background levels of tritium in areas not related to the streambed, which range from 40 to 50 Bq/L. The results of snow cover measurements in different seasonal periods were compared. The main mechanisms causing tritium transfer in snow were examined and identified. The most important mechanism of tritium transfer in the streams is tritium emanation from ice or soil surface.

1. Introduction

Many investigations devoted to studying artificial radionuclide migration to the environment both on the territory of the experimental site "Degelen" and beyond it have been carried out. Among the most hazardous artificial radionuclides, such as ^{137}Cs, ^{90}Sr, $^{239+240}Pu$, and ^{3}H (tritium) present in this ecosystem, tritium has the highest migration rate. In (Subbotin et al., 2010; Lyahova et al., 2007) high tritium concentrations in surface and ground waters as well as in the components of the ecosystem (animals, plants, atmospheric air) were registered. The tritium concentration in the surface waters of the streams on the site Degelen goes up from tens to hundreds of thousands of Bq/L, and the lengths of streambeds of some streams exceed 10 km, therefore they go beyond the territory of the Degelen massif.

A comparative analysis of the tritium concentration in the ecosystem components showed that the main contribution to the ecosystem contamination is made by the streams located on the territory of the Degelen massif. This research will allow to estimate to what extent the contamination with tritium spreads beyond the Degelen massif, and to estimate contamination of the air environment with tritium. Our experimental data can be used for identification of places where nuclear tests were based on the concentration of tritium in the snow cover. In different climatic periods of snow accumulation, the tritium inflow may be caused by the two main transfer mechanisms:

- Tritium inflow from the atmosphere as a result of transfer of snow particles or condensation of water vapor on snow particles during precipitation, or
- Tritium emanation from soil or ice cover.

This research is devoted to studying of the degree of influence of transfer mechanisms on tritium spatial distribution in the snow cover and estimation of the tritium background concentration on the test ground of Degelen.

2. Objects and methods of investigations

The snow cover was studied in the spring–winter period. The areas to be studied were chosen based on the results of studying of other ecosystem components (atmospheric air, plants, water vapors of atmospheric and soil air). The objects of investigation were the streams Karabulak, Uzynbulak, Aktybai and Baytles which go beyond the Degelen massif (Fig. 1). Fig. 1 shows the scheme of location of studied profiles in the streambeds.

The examination of the snow cover consisted of 4 main stages:

- Reconnaissance on the territory, choice of sites to be studied;

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- Studying of tritium distribution in-depth of the snow cover in the centers of streambeds;
- Studying of spatial tritium distribution relative to the streambeds;
- Studying of tritium concentration dynamics in the snow cover.

To estimate the spatial distribution of tritium, the profiles perpendicular to the water flow were made on the on the right and left sides of the streams. The center of the profile was located in the center of the streambed, the distance between the investigated points was 50 m (Fig. 2), and the depth of sampling was 0–10, 10–20 and 20–30 cm (Fig. 3).

To investigate tritium concentration dynamics in the depth of the snow cover at Uzynbulak and Baytles streambeds, 3 research spots were located:

— Directly into the streambed;
— At a distance of 50 m away from streambed; and
— At a distance of 300 or 800 m away from streambed.

Each spot did not exceed 4 m^2. For the purpose of visual estimation of snow cover layers, the facial layer was marked by a layer of sand with 0.1–0.3 cm thickness. Samples of snow were taken after compaction of new-fallen snow.

Samples of snow were taken layer-by-layer at the Uzynbulak streambed, at depths of 0–10, 10–20 and 20–30 cm, and on the Baytles streambed at depths of 0–1 cm (snow crust), 1–3 cm, 3–6 cm and 6–10 cm. The snow cover thickness was measured with a measuring bar.

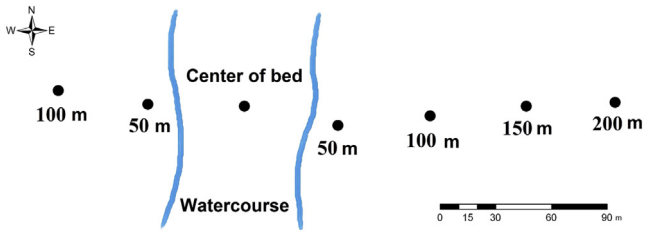

Fig. 2. Points in the research profile.

To determine tritium concentration, the snow samples were placed in the polyethylene bag and thawed to a liquid state. In order to remove mechanical admixtures, the melted snow samples were filtered using “Whatman 589/3” filters. The filtered sample was placed in a 20 mL plastic vial with scintillation cocktail Ultima Gold in a proportion of 3:12 mL, respectively. We used a liquid scintillation spectrometer TriCarb 2900 TR and standard techniques (ISO 9698, 1989).

Background tritium concentrations were measured on conventionally clean areas, not related to tritium contamination. For this purpose the areas in Kurchatov-city and beyond the perimeter of the Degelen massif in points P-12, P-14, P-15 and P-19 were chosen (Fig. 1).

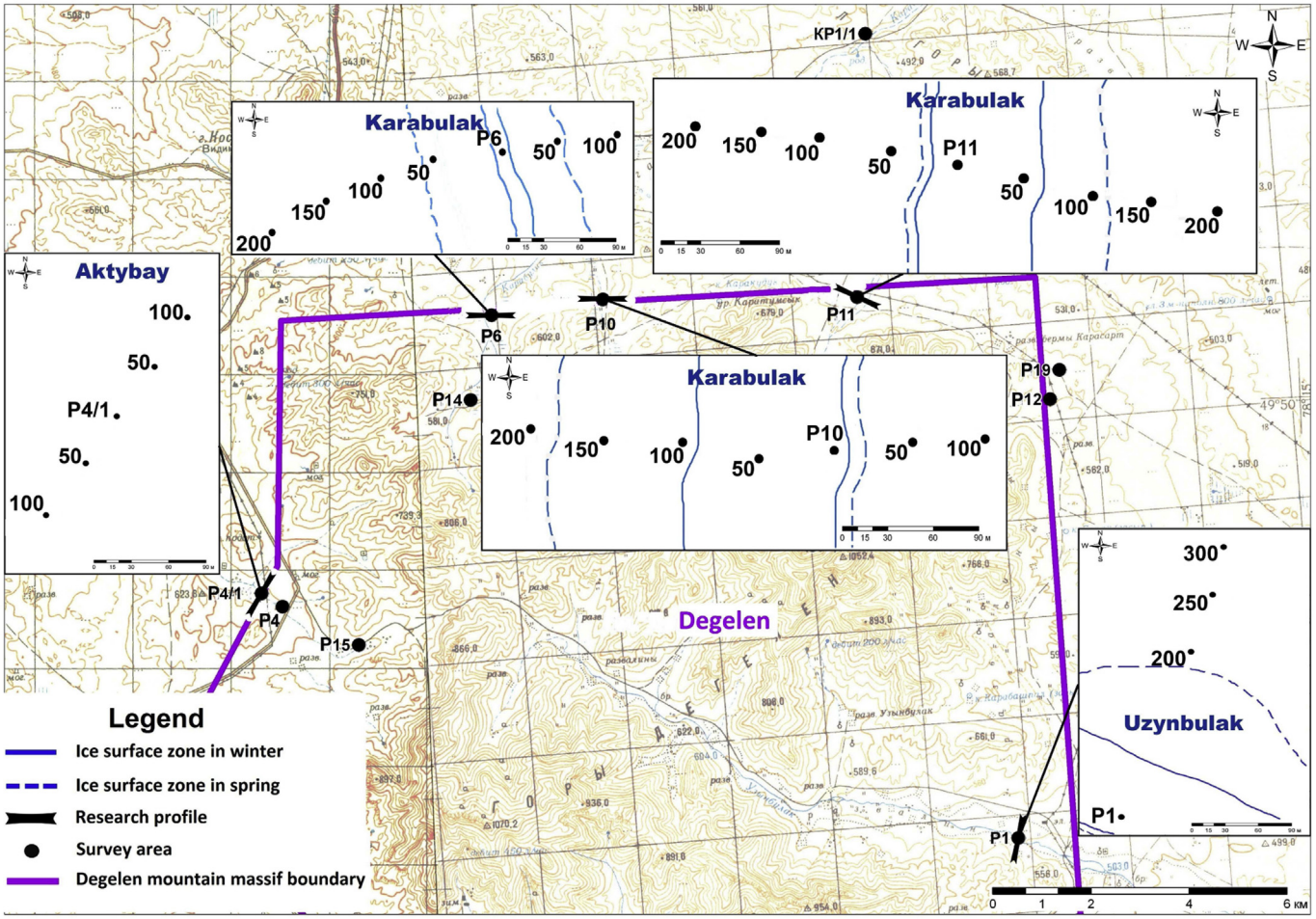

Fig. 1. A scheme of location of studied areas.