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ANALYSIS OF GLACIER ACTIVITY AT ALEXANDRA LAND ISLAND OF FRANZ JOSEPH LAND ARCHIPELAGO

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The significant warming of climate is an origin to and a consequence of numerous natural processes. A good example is a melting pace of glaciers that has increased in the recent time. The changes in the atmospheric circulation lead to an alteration of meteorological properties. The resulting shift of snow cover, its dynamics and water balance are both a consequence and an indicator of such change [Kitaev, Titkova, 2013]. Thus the acquisition of any data on glacier processes is an important task.

A glacier is a source for a variety of seismological phenomena starting with micro cracking that follows the movement of ice blocks and ending with earthquakes reaching magnitude of 5 and followed by scabbing of several cubic kilometers worth of ice. The continuous monitoring of glacier seismic activity is being performed by non-Russian scientists [Meredith Nettles, Göran Ekström, 2010] mostly, while the similar studies just start in Russia.

The most northern seismic monitoring station “Franz Joseph Land” was opened in September 2011 by a scientific group of the seismology laboratory of IEPN UB RAS institute [Danilov, Konechnaya, 2012]. Seismogram analysis revealed a lot of local events with epicenters belonging to the area of Lunnyj and Krapotkin ice domes on the Alexandra Land Island (Fig.1). These include both regular high-frequency cracking caused by inter-glacier processes and the scabbing of huge blocks with the consequent impacts of the blocks hitting the seabed [Danilov, 2013]. Seasonal changes dictate the dynamic behavior of glaciers by a large degree. The heating in summer and cooling in winter cause a massive redistribution of tensions and are revealed as the density of events changing from month to month (Fig.2a). The amount of registered events from September to December has grown considerably in 2012 and 2013 compared to the first measurements in 2011 (Fig.2b). However, the time range of data available is not enough to draw certain conclusions regarding the nature of the observed events.

The glacier got active in august 2012 and micropulses were measured by means of a wide-band station CMG-6TD by Gurlap. It was placed at Nimrod cape near Lunnyj ice dome (Fig.1). During the 3 hour session few ice events registered were accompanied with loud sounds and the microseisms contained characteristic perturbations (“long period wells”) that include a large amount of high-frequency peaks. This kind of phenomena was never registered by the station positioned 20 km away (Fig.3).

Fig.4 contains coherency-time analysis plots (CTA-diagrams are used to reveal weak pulses [Yudakhin, Kapustian, Shakhova, 2008]). The events discussed manifest themselves as wide stripes in 5 to 50 Hz range (1800 s and 2500 s in Fig.4). The phenomena is most prominent in NZ plane while no signs of wells are present in EN plane. This is an indication of dynamic processes taking place in the body of the glacier as low-frequency changes that are accompanied with high-frequency pulses. Background high-frequency micropulses are present in CTA-diagram as a wide vertical stripe in 25-35 Hz range and are mostly found in EN plane. This can be explained by the inner “life” of the glacier with blocks slowly shifting in horizontal plane.

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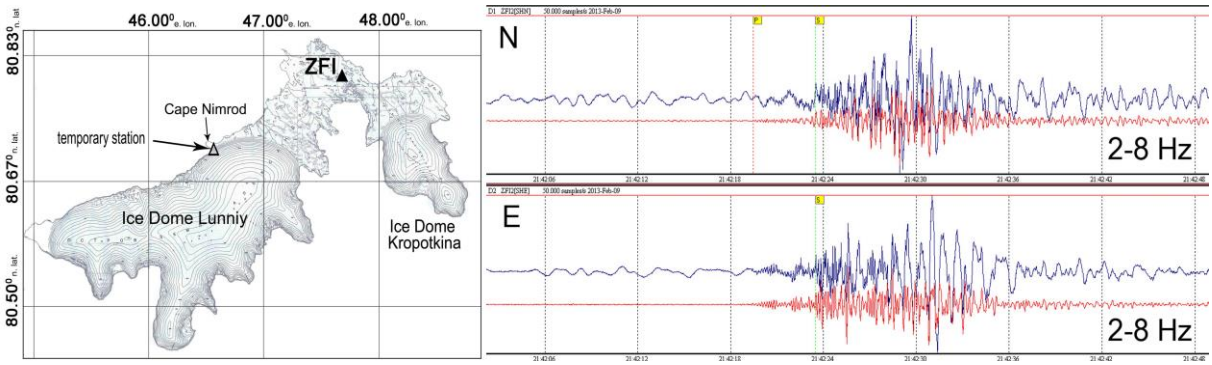

Fig.1. Map of Alexandra Land Island of Franz Joseph Archipelago (left) and a typical view of local events waveforms (right)

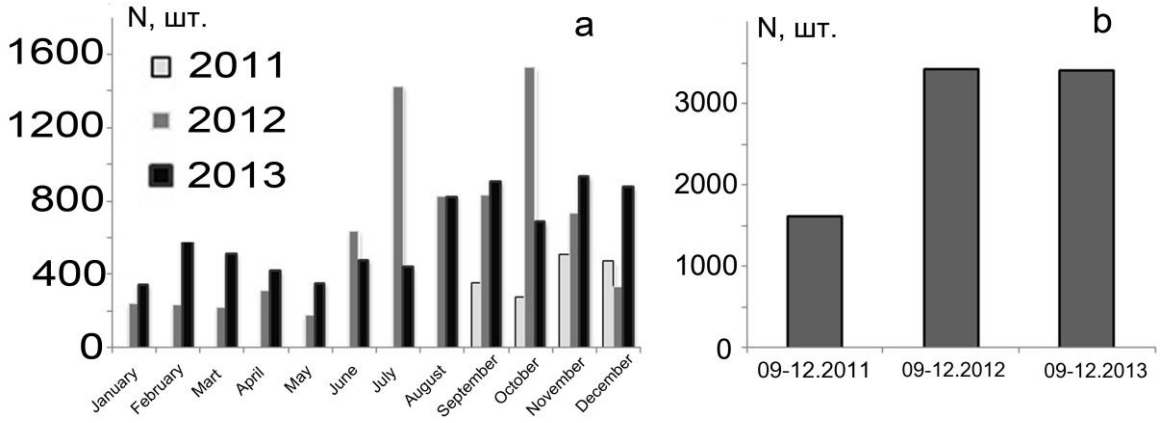

Fig.2. Distribution diagram of glacier events measured by ZFI station by a) month and b) years (September to December interval)

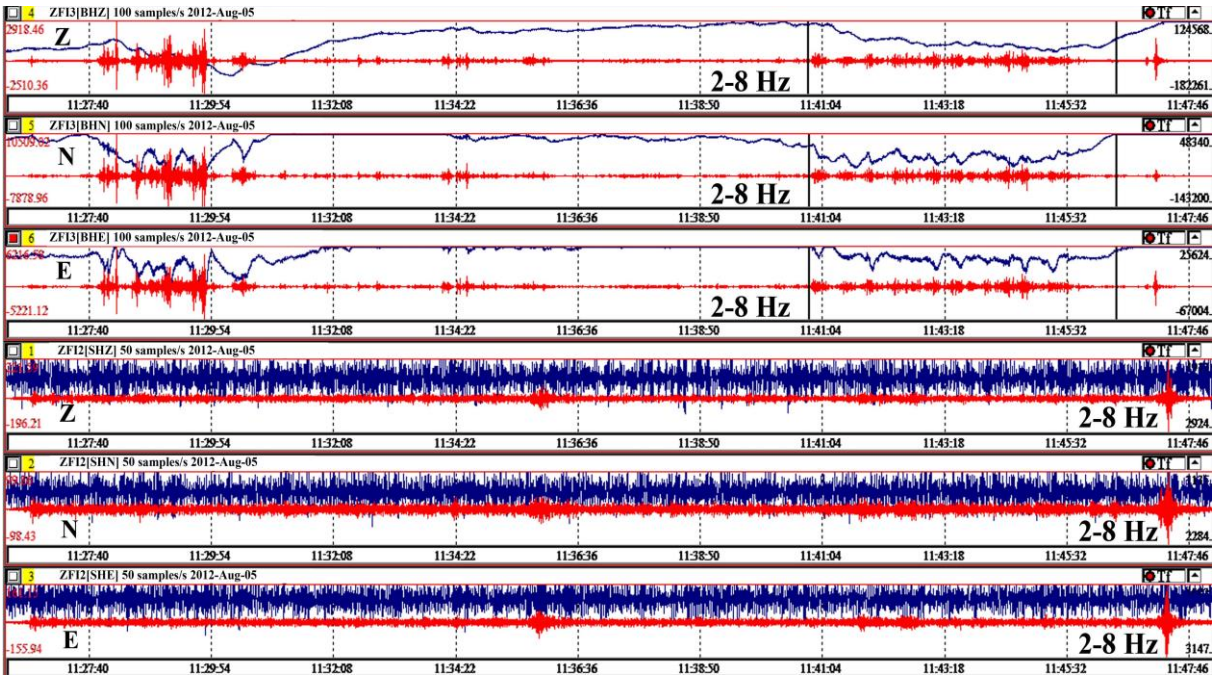

Fig.3. “Long period wells” waveforms as registered by a) temporal and b) stationary seismic stations. Blue – real waveform, red – filtered waveform in 2-8 Hz range

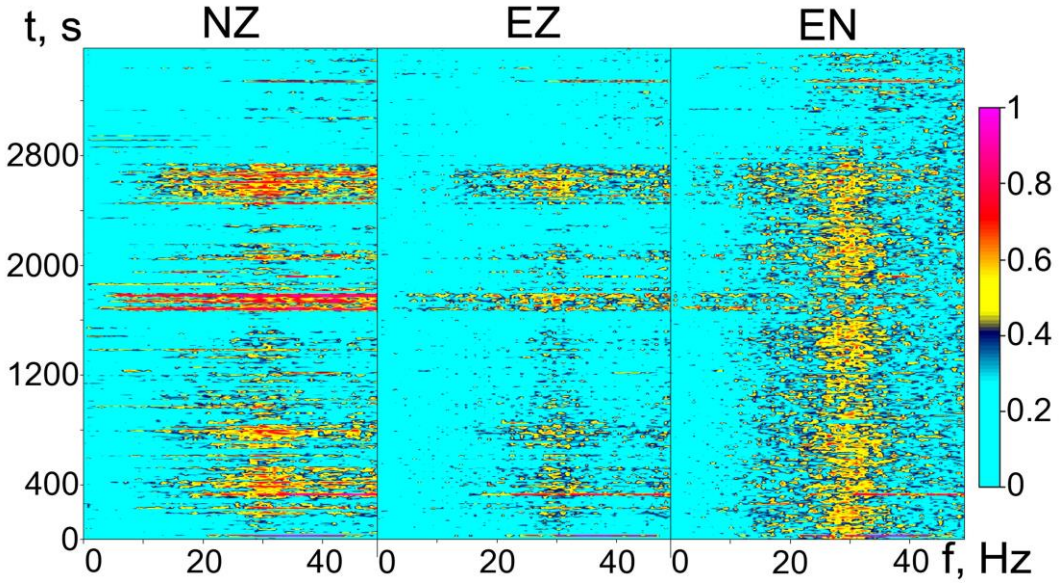

Fig.4 CTA-diagram by the wide-band measurement system situated near the Lunnyj ice dome at Nimrod cape

Ice is generously inhomogeneous and contains lots of cracks, thus one can expect that shifts across any of the fractures may generate pulses when moving and stumbling against sides.

Microseisms analysis allows investigation of glacier dynamics and of bed media dynamics given the meteorological factors are concerned. This method can use island glaciers as a peculiar tool for the previously impracticable monitoring of Arctic geodynamics.

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