

Stability of geodetic reference points in Ny-Alesund permafrost ground from one year of tilt monitoring

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Comparison of station velocities of VLBI and GPS reference points at the Ny-Ålesund Space Geodetic Observatory, Spitsbergen has questioned the stability of the basements of the antennas over time spans of several years. Due to its high latitude of almost 79° N, the site is of crucial importance for the world geodetic reference frame. The two antennas which became operational some ten years ago are roughly 100 m apart from each other. They have been fixed to concrete basements, erected in the permafrost ground, at 40 m above sea level. At the test site, the subsoil is melting down to 3 or 4 meters during the arctic summer. The basement of the VLBI antenna which has a diameter of 20 m is more massive than that of the GPS antenna. Both the basements are in contact with the bedrock, consisting of a folded sedimentary hard rock at several meters depth. In near distance from the basements, the terrain falls steeply to the Kongsfjord.

From August 2001 up to October 2002 we have operated three quasi-continuously recording tiltmeters of resolution 0.1 microrad on the tops of the basements. The purpose of this campaign was to monitor micro-movements over a period where relevant changes in ground frost conditions take place which might affect the stability of the antenna basements. By using tiltmeters we are generally unable to see any translational movements e.g., in vertical direction; rather we can infer from the presence of significant tilt movements that the stability of the basement is reduced.

Several tests with various configurations of instrumental set-ups were conducted in the initial phase of the campaign. Analysis of these tests has revealed that the magnitude of tilt induced through repositioning of the VLBI antenna is of order 10 microrad. The dominant part of this tilting appears to be internal deformation (bending) of the concrete basement rather than tilting of the basement in whole.

Inspection of the 13 months long recordings suggests stable conditions for the basement of the GPS antenna at Ny-Ålesund, on the 50 microrad level. For the basement of the VLBI antenna, the situation is less clear. There is evidence for permafrost-driven instability in May - July 2002, however, with some doubts remaining due to partial malfunctioning of the single tiltmeter that was operated here. The instrument was exposed to large temperature variations and presents questionable temperature sensitivity in one of its components. Still, adopting conservative estimates, the total observed tilt signal reflects rotational movements of the entire basement, which do not exceed 1 millimetre (per length of the basement).

With respect to the importance of the VLBI measurements at this exceptional point and the considerable investments that have been and are still being made to operate the VLBI system it is recommended to extend the tilt measurements in order to obtain clarity about the stability of the subsurface at this place.