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Exploration of Gamburtsev Subglacial Mountains, East Antarctica: Background and Plans for the Near Future

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The Gamburtsev Subglacial Mountains (GSM), located in the central part of East Antarctica, were discovered by the Soviet team of the 3rd Complex Antarctic Expedition in 1958-1959. The GSM has highly dissected Alpine topography reaching maximum elevations of 3000 m and are completely covered by over 600 m of ice and snow. The mechanism driving uplift of the young-shaped GSM in the middle of the old East Antarctic Shield is unknown. With only limited constraints available on the topography, geology, and lithospheric structure, the origin of the GSM has been a matter of considerable speculation. The latest interpretation suggested that the GSM were formed during Permian and Cretaceous (roughly 250-100 Ma ago) due to the combination of rift-flank uplift, root buoyancy and the isostatic response. Later on, the Antarctic Ice Sheet covered the range and protected it from erosion. However, this theory cannot explain lack of erosion process during many millions years in between uplifting and beginning of glaciation. The next step of the GSM exploration focuses on the direct observation of ice sheet bed by drilling. In order to penetrate into subglacial bedrock in the GSM region the development activity already has been started in China. Drilling operations in Antarctica are complicated by extremely low temperature at the surface and within ice sheet, by ice flow, the absence of roads and infrastructures, storms, winds, snowfalls, etc. All that are the reasons that up to the present moment bedrock cores were never obtained at inland of Antarctica. It is proposed to use cable-suspended drilling technology in which an armored cable with a winch is used instead of a pipe-string to provide power to the down-hole motor system and to retrieve the down-hole unit. It is assumed to choose the drill site with the ice thickness at most of 1000 m and to pierce into the mountain slope to a depth of few meters. Proposed borehole construction includes five following steps: (1) dry core drilling of upper permeable snow-firn layer with bottom-air reverse circulation; (2) reaming; (3) casing installation; (4) fluid core drilling of glacial ice with bottom-fluid reverse circulation; (5) bedrock core drilling. All drilling equipment will be installed inside a movable sledge-mounted warm-keeping and wind-protecting drilling shelter that is transported to the chosen site with crawler-tractor. The new approaches of subglacial bedrock drilling technology are connected with utilization of environmental friendly, low-toxic drilling fluids, e.g. low-molecular dimethyl siloxane oils or ester type. They have suitable density-viscosity properties, and can be consider as a viable alternative for drilling in glacial ice and subglacial bedrock. According to approved schedule, the first field tests are planned to carry out just outside Zhongshan Station near Antarctic coast in season 2015-2016. Next season 2016-2017 the movable drilling shelter is planned to be transported to the chosen drilling site in the GSM region, and drilling to the bedrock would be finished during two seasons.