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Glaciological setting and subglacial conditions at Little Dome C, the future site for Beyond Epica – Oldest Ice Core

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Ice domes in the interior of East Antarctica are ideal candidates in the quest for the longest continuous record of climate in polar ice. They are in areas with low surface precipitation, low horizontal advection and large ice thickness. However, the age of the ice near the bottom of the column is very sensitive to subglacial thermal conditions as they can promote basal melting and the loss of the bottommost and oldest ice. Here we report the main findings from a geophysical survey and a shallow, 460m depth, rapid access drilled borehole. We use a low frequency radar, DELORES, to survey the area and detect subglacial melting; a phase sensitive radar, ApRES, to obtain englacial vertical strain-rates and crystal orientation fabrics in selected sites; and, at the drilling site, borehole temperature and water isotope data in the top 460m. Our main findings are: 1) The subglacial topography is characterized by topographic highs criss-crossed by deep valley troughs with typically 0.5-1km difference in height. There is evidence of subglacial melting in the troughs. However the ice stratigaphy, that we survey in detail with DELORES system with 500m grid, drapes over the rough topography and the topographic highs are presently melt-free. 2) The optical birefringence, observed in ApRES polarimetry, shows two aligned crystal orientation fabrics that are typical for glacial periods. This indicate uniform ice-flow conditions during, at least, the last two glacial-interglacial periods and is consistent with the polarimetry from EPICA Dome C. 3) Using the borehole temperature, englacial strain-rates and temperature records from EPICA Dome C we estimate that the geothermal heatflux in the area is 55 +/- 1 mW/m2. Also we find that, due to the delay between basal and surface temperatures, the basal temperature at Little Dome C is currently the coldest and was 0.5 C warmer 80 kyrs ago. We estimate that any topographic high where the ice thickness is below 2810 +/- 10 m was melt-free during the warmest conditions. This information, together with other evidence, lead to choosing the site for the future Beyond Epica – Oldest Ice Core project.