

Third Dome Fuji Deep Coring: an Oldest Ice Core

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Ice cores collected from the Antarctic ice sheet are time capsules that enable us to reconstruct the past environmental changes such as temperature, atmospheric composition, dust and aerosols, from local to global scales. Two deep ice cores have been drilled at Dome Fuji, East Antarctica, which contain continuous environmental signals over the past 720,000 years. The Dome Fuji core is the second oldest deep ice core next to the EPICA Dome C core that is 800,000-years old (the third oldest core is the Vostok core with 420,000 years). These coring sites have basal melting; thus, the older ice does not exist beneath these sites.

The International Partnership in Ice Core Sciences (IPICS) has proposed "Oldest Ice Core" project since the early 2000s, which aims to collect ice cores dating back to 1.5 million years ago, covering the climatic transitional period (Mid-Pleistocene Transition) when the periodicity of glacial-interglacial cycles changed from ~40,000 to ~100,000 years. Such old ice cores may be collected around the inland domes and ridges of East Antarctica, given that the ice sheet is frozen to bedrock (thinner ice and/or smaller geothermal heat flux) and horizontal flow is slow. As emphasized by IPICS, to ensure the reliability of data from the oldest ice cores, it will not be enough to drill only one ice core at one site in Antarctica, because the old ice layers are expected to only exist in the layers within 100 – 200 m from the bedrock where the ice is warm and the thinning is extreme. This, it is highly important to collect multiple ice cores from different regions and compare the results, which can only be done with the international efforts. The European and the Australian projects have determined the drilling sites near Dome C, and other countries aim to drill ice cores at different sites. The drillings in the different regions are complementary towards the ultimate goal of obtaining the reliable climatic records.

With these backgrounds, the Japanese Antarctic Research Expedition (JARE) has conducted its inland activities to locate potential sites for collecting an Oldest Ice Core in the Dome Fuji region. During its Phase IX 6-year program, JARE carried out ground-based glaciological surveys to select deep drilling points near Dome Fuji where old ice may exist. In JARE 59, 60, and 63, extensive field activities including radar surveys were conducted, mainly in the southern area of the Dome Fuji region. Currently, the optimal drilling site is being investigated through the analyses of the data obtained from these activities combined with numerical modeling of the ice sheet.

In the JARE Phase X, the main construction of the drill site will take place in JARE 64 and 65, and the deep drilling (from on-site preparation to reaching the bedrock) is expected to progress from JARE 65 to 68, in parallel to the further developments (in Japan) and deployment of deep drill and logging device, as well as new technologies such as deviation drilling and rock coring towards the last part of the Phase X. The main outcome of our Phase X project will be the acquisition of the ice core dating back more than one million years (the analyses and research will require budgets outside JARE). The analyses of the old ice cores for various species such as water isotopes, impurities and gaseous components that record regional- to global-scale climate changes may shed light on the unresolved climatological questions such as the causes and processes of the Mid-Pleistocene Transition. The scientific activities other than deep ice coring include glaciological observations from the coastal to inland regions for better understanding of the recording processes of environmental parameters on the ice sheet, near-surface snow and firn properties (such as critical factors for surface albedo), as well as surface mass balance and precipitation.