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Drilling towards Lake Vostok and accretion ice studies

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It is now recognized that subglacial water has been playing significant role in many processes that have shaped the Antarctic continent and its ice sheets today and in the past. Lake Vostok is an essential element of the Antarctic subglacial hydrological system and the largest known subglacial lake on Earth (with an area of about 16,000 km2 and the water volume exceeding 6,000 km3). The Russian Vostok Station sits at the southern end of the lake where the sub-ice water freezing onto the base of the Antarctic ice sheet has formed a 200-250 m thick layer of accreted lake ice separating the ice sheet from the 600 m deep water body underneath. In 1998, deep hole 5G-1 drilled at Vostok by the Russian Antarctic Expedition (RAE) penetrated into accreted ice at 3,539 mbs. The study of the ice samples extracted as a core from the hole has provided first information on the geochemical conditions and potential biological residents of the lake.

In January 2009, the drilling of hole 5G-1 was abandoned at a depth of 3,667 m due to a drill accident. The new branch-hole 5G-2 was started by deviation from 5G-1 at 3,585 m depth so that to allow replicate coring of the ice layer bedded between 3,606 and 3,607 m that comprises large mineral inclusions of lake sediments. In the austral season of 2010-2011, RAE resumed drilling of the 5G-2 hole and with an electromechanical drill adapted for "warm ice" reached a depth of 3,720 m thus leaving less than 50 meters of undrilled ice between the hole and the lake.

The advance in drilling of 5G-2 in 2009-2011 yielded 120 m of new ice core (66 m of the replicate core and 54 m of core representing uninvestigated so far thickness of lake ice). The studies of the fresh ice core performed in the field allowed to continuously document the evolution of the accretion ice fabric and texture with depth as the hole approached the ice-water interface. At the beginning of the new hole deviation the replicate 5G-2 core reveals textural and fabric properties which are clearly distinct from those observed in the overlapping section of the 5G-1 core. This distinction has been attributed to a modification of original ice texture by rotation recrystallization occurred in ice in proximity of the 5G-1 hole wall in the course of rapid hole closure caused by the high ice-fluid pressure difference (up to 1 MPa) that has been allowed in 5G-1 at the time of the drilling accident.

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