Geophysical Research Abstracts, Vol. 8, 07109, 2006
SRef-ID: 1607-7962/gra/EGU06-A-07109

Concurrent evidences for hydrothermal activity in the subglacial Lake Vostok, East Antarctica

S. Bulat (1), G. Leitchenkov (2), V. Lipenkov (3), V. Lukin (3) and **J-R. Petit** (4)

(1) Petersburg Nuclear Physics Institute RAS, St. Petersburg, Russian Federation, (2) Research Institute for Geology and Mineral resources of the World Ocean, St. Petersburg, Russian Federation, (3) AARI, St. Petersburg, Russian Federation, (4) LGGE CNRS, Saint Martin d'Hères, France (petit@lgge.obs.ujf-grenoble.fr

Lake Vostok is viewed as a long-term isolated ecosystem featured by extreme life conditions often compared to those expected for icy planets and moons. The accretion ice retrieved by deep ice coring provided the best template and unique opportunity for searching for life in this subglacial environment. Up to now, no confident findings of revived microbes including cold living bacteria have been reported for the deep glacier ice which supplies the water body by melting. This indicates the lake biota has no links to the ice sheet surface. In contrast, 15-20 kyr old accretion ice with trapped sediment inclusions showed DNA signatures of thermophile chemolithoautotrophic bacteria (Bulat et al., 2004, Petit et al., 2005) suggesting that their origin and resources are in the deep surrounding bedrock. Here we present complementary indices to support hydrothermal contribution to Lake Vostok which does not originate from a mantle activity.

The first evidence is the geological setting. Lake Vostok may represent a preglacial palaeorift depression bordered by deep-crustal faults (Leitchenkov et al., 2005) or alternatively slightly reactivated ancient trust (Studinger et al, 2003). In any case helium isotope studies of accretion ice show the He^3/He^4 ratio which is typical for an old continental province. This suggests that the Lake Vostok is rather fossil structure in terms of mantle-derived heating. Nevertheless, up to 1500 m deep bedrock depression of Lake Vostok not filled by sediments may denote recent intraplate crustal subsidence which seems to be rather weak in comparison with active tectonic processes but sufficiently strong to reactivate old faults within the lake depression. Recorded microseismic activity near Lake Vostok (Studinger et al., 2003) provides the convincing

evidence of tectonic deformations which could drive energy and groundwater convection.

The second, a ^{4}He degassing owing to long-term tectonic activity. The absence of ^{3}He enrichment in the accretion ice excludes the high enthalpy mantellic contribution. At the same time a three-fold ^{4}He excess which is observed in 15-20 kyr old accretion ice with respect to the overlying glacial ice (Jean Baptiste et al., 2001) suggests degassing of bedrock radiogenic He through the fault vents. The maximum of ^{4}He concentration appearing in the upper part of accretion ice supposes the fault vents are located upstream drilling site, likely in a shallow depth bay which extents prior the glacier floats over the deep lake (Petit et al., 2005).

Third, the mean isotope composition of accretion ice indicates a deuterium excess value (d=δD-8*δ^{18}O) is lower than in any overlaying ice from the Lake Vostok area **(**Petit et al., 2005, Ekaykin et al, 2005). Since the lake is supplied by glacier, the enrichment of lake water in ^{18}O can be due to oxygen isotopes exchange with ^{18}O-rich surrounding rocks. Such a phenomenon is observed in volcanic, geothermal and oil fields areas ("^{18}O shift" of Craig, 1963). This suggests that hot temperature waters circulate in great depths within the bedrock and sediments of Lake Vostok.

Fourth**,** electron microscopy and chemical analyses of solid inclusions in the accretion ice revealed small (micron-sized) particles of sulfide minerals (molybdenite, sphalerite, and pyrite) which are typical products of hydrothermal processes. Good preservation of sulfides in the expected oxidative conditions of Lake Vostok and their original crystalline shape suggest that these minerals formed *in situ* as a result of modern endogenous activity and have been rapidly trapped by frozen ice.

Fifth, chemical analyses revealed that the accretion ice and the solid inclusions within are enriched in sea salt, calcium and magnesium sulfates (gypsum) with respect to the glacier ice. The sulfates are of sedimentary origin as indicated by oxygen isotopes (^{17}O, ^{16}O, ^{18}O) (De Angelis et al, 2004). But NaCl enrichment and brine droplets detected in accretion ice (De Angelis et al, 2005) is certainly the most extraordinary phenomenon. A rapid intrusion process of saline material into accretion ice may be viewed as a possible mechanism. A hydrothermal fluid passing through an ancient evaporitic reservoir boosted by scarce seismo-tectonic activity appears the best scenario for such findings.

Thus, thorough investigations appeal for a hydrothermal contribution supporting a possible thermophile life and existing in deep faults of bedrock and sediments under the Lake Vostok. This is likely the consequence of the resulting fractured thick bedrock structure and old tectonic activity instead of a contribution from the Earth mantle. Ongoing drilling project aiming to collect deeper accretion ice representative of open

lake water conditions would provide new opportunity to unravel a mystery of life in the open lake.