



An interesting natural phenomenon - giant rings on Lake Baikal ice

Alexei Kouraev (1,2), Michail Shimaraev (3), Frederique Remy (1,4), Andrei Ivanov (5), and Boris Golubov (6)
(1) Universite de Toulouse; UPS (OMP-PCA), LEGOS, Toulouse, France, (2) State Oceanography Institute, St. Petersburg branch, Russia, (3) Limnological Institute, Siberian Branch of Russian Academy of Sciences, Irkutsk, Russia, (4) CNRS; LEGOS, F-31400 Toulouse, France, (5) P.P.Shirshov Institute of Oceanology, Moscow, Russia, (6) Institute of Dynamics of Geosphere, Moscow, Russia

Starting from May 2009 scientific community and large public have been puzzled by the formation of giant rings on Baikal ice. These rings (diameter 5-7 km, thickness of dark layer - 1 - 1.8 km) have almost perfect circular shape what makes them so interesting and attractive not only to scientists, but also for large public. . The rings have been observed since 1999 by various satellites and sensors (AVHRR, MODIS, Landsat, SPOT) as early as 1999 but probably also in 1984 and 1994 (Shuttle missions). These rings are usually well observed in April, when snow cover is thin or absent. Rings have been observed in the southern tip of the lake (2009), and in three places in the central part: near Krestovskiy cape (1999, 2003, 2005 and 2008), near Turka (2008), and near Cape Nizhnee Izgolovye (2009). All these places are located in the region of steep bottom topography, over depths of more than 500 m. According to in situ measurements done by the Limnological Institute in Irkutsk in 2009, ice thickness is about 70 cm in the center and on the outside of the ring, and 40 cm in the ring itself.

It is known that the Baikal lake has important hydrothermal activity, and there are numerous observations of gas (methane etc) seepage from its 7 km-thick layer of bottom sediments. Local-scale absence of ice cover (steamthroughs or "propariny") is typical for some places in Lake Baikal. They result from gas emissions (associated with rise of warm water), near capes and straits (due to better vertical mixing), thermal sources, outlets of large rivers. Often they are observed near Capes Big and Small Kadil'niy, and in the Olkhonskiye vorota strait. However they size ranges from just a half a meter to several hundreds of meters (but not several kilometers) and this could not be an explanation for the formation of giant rings.

We present several existing hypotheses of the origin of these rings including gas emission, heat flux, cyclonic subsurface currents and mega-bubble formation due to gas seepage and discuss strengths and weaknesses of each hypothesis. We also discuss the possibility of methane release from gas hydrates deposits that occur at depths more than 350-500 m in the Southern and Central Baikal. Hydrates can be destabilised by tectonic/seismic activity or by increased heat flow due to hydrothermal activity and lead to catastrophic gas blow-out events. We analyse the timing of observation of ice rings and regional seismicity from the USGS seismic data (earthquake activity and hypocenter depth) showing recent changes between 1992 and 1999.

We present observation of the formation, development and disappearance of these rings using optical and infra-red imagery (MODIS, Landsat), complemented by SAR imagery (ERS-2 SAR, ENVISAT ASAR). We also analyse radar altimetry observations (ENVISAT RA2) in the region of Cape Krestovskiy in the Middle Baikal. We discuss the conditions needed to create and maintain these rings, the timing of and duration of their existence, as well as horizontal and vertical structure of ice and snow cover before and during the appearance of rings.

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