# Saving two private Hammers description of field work in the Middle Baikal in February and March 2016 

Alexei Kouraev, 12 April 2016
(minor updates 28 January-12 February 2020)

This is an informal description of ice conditions, scientific work in the region of a giant ice ring in 2016 and the danger of ice rings for transport. To get more information on the phenomenon of ice rings, how they are formed and where they are found please see our web site www.icerings.org as well as our papers published in 2016 and 2019 (see "Publications" on the last page).

Since 2010 we have conducted scientific expeditions every winter (end of March) on Lake Baikal ice in the region of giant ice rings. Starting in 2016 we organised not one but two expeditions - one in mid-February and one in mid-March, and we also installed scientific instruments in the ice between these two expeditions. 2016 was also a year when an ice ring appeared unusually early and was well developed. This is the story of what we saw and measured and what happened that winter.

## A. 12-14 February 2016.

Working in the region near Cape Nizhneye Izgolovye (Middle Baikal) where ice rings are often observed, we have discovered unusual water structure (temperature, conductivity and density) that is typical for eddies associated with ice rings (Figure 1). We did several transects across the eddy, and have installed two 100-m long ropes with temperature loggers (at depths 5, 25, 45, 65 and 85 meters) and current meters (at 45 m depth). The ropes were anchored in the ice and weighted at the bottom by two hammers ( 1.5 and 2 kg , Figure 2). One rope was installed outside the eddy (A), and another one inside (B). The ice was relatively thick ( $45-60 \mathrm{~cm}$ ) and stable.

We planned to go back in late March a) to do new sets of measurements, b) to see whether an ice ring has manifested in this location, and c) to retrieve the costly instruments with precious measurements and, of course, to get back the hammers!


Figure 1. Station locations in February 2016 (first two numbers - date), red zone - unusual warm water both below and above 45 m depth (main eddy zone), blue line - unusual water below 45 m (zone somewhat affected by the eddy). Background image: Landsat, 28 January 2016


Figure 2. Roman and Alexei are preparing a rope with instruments and a hammer to be deployed in water. Photo: A. Suknev

## B. Mid-March 2016.

The ice ring appeared on satellite images unusually early - on 14 March (Fig 3), with an outer diameter of 6.6 km (ring width was 1.7 km ).


Figure 3. Satellite images (MODIS) from 14 (left) and 18 (right) March 2016 for the Nizhneye Izgolovye region.

At about the same time two off-road vans (UAZ) encountered problems on the ice. On 16 March one UAZ going from Olkhon Island to Ust-Barguzin fell through the ice in the region of the ice ring (the driver and passengers were rescued, but the vehicle and most of the luggage was lost).

On 18 March 2016 at the eastern boundary of the ice ring another UAZ vehicle broke through the ice, but fortunately got stuck (Fig 4a). The driver (our friend Alexander Beketov) and German tourists managed to get out via the roof entrance (the side doors were jammed by ice). The next day the vehicle was rescued (Figure 4b) and Alexander even managed to turn the engine on and drive home.

a)

b)

Figure 4. UAZ trapped in the ice (a) and rescue activities (b) at 19 March 2016 (photos by A. Beketov)

## C. Late March 2016.

Our expedition arrived on 27 March at Ust'-Barguzin. The ring was already in full glory (Figure 5), with the ring location corresponding well to the zone(s) defined by our earlier observations in February.


Figure 5. Satellite image (MODIS) from 29 March 2016 and zones affected by the eddy (see Fig. 1).

In view of his recent experience, Alexander suggested that UAZ is not a good type of vehicle to drive on ice in the ring region, so the next day ( 28 March) we drove by a Trekol car with people from the Ministry of Emergency (Figure 6a). This is a $6 \times 6$ car, with huge low-pressure tyres, which can drive on thinner ice than the UAZ and other common types of car. The first rope (A, outside the ring) was relatively easy to find, the ice was thick ( 57 cm ) and stable and did not move between February and March. The rope with instruments and the first hammer were retrieved.

a)

c)

Figure 6. a) Trekol on ice, b) and c) - recovering equipment (and hammer) from the water. Photos by A. Suknev.

However our further approach towards the second rope was not that easy. After doing the second CTD station, at some further point we realised that the ice was covered with numerous holes (Figure 7) and further driving would have been lunacy.

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Figure 7. Ice in the region of Trekol stop. a) Open water and thin ice, b) this is what may happen when you stand on a stable part with one foot and touch thin ice with your other foot. Photos by A. Suknev.

So we (Andrey and Alexei) decided to go by foot and try to reach the second rope ( 3 km from that point). We put on wonderful orange dry suits (courtesy of our colleagues from the Ministry of Emergency), that keep you dry and also have buoyancy (Figure 8).


Figure 8. Nansen and Johanssen leaving Fram to try to reach the North Pole on skis. ...No, sorry, this time it is Andrey and Alexei leaving the Trekol to try and reach the second rope on foot.

The ice reminded us of either Swiss cheese or a minefield (depending on your mood), where solid 35 cm thick ice has been marked everywhere by patches of open water and thin ice just waiting for you to step on it (Figure 9a). Carefully weaving our way on the ice, we managed no more than 500 m from the Trekol, before we were stopped in our tracks by a long (several hundred meters) and wide (1-2 m) lead (Figure 9b). Trying to go left - another minefield. Going right - another lead, this time perpendicular to the first one. Andrey suggested to swim across the lead and then continue on foot, but we after some reflection we decided not to. Little did we know that day, that further away this lead the situation would get much worse - we had been just on the edge of the ring (Figure 10) and much more open water was out there waiting for us.


Figure 9. a) Large (about 80_90 cm wide) air bubble below ice, which is probably just several cm thick, b) Alexei before the lead, unsure what to do, c) wind creates ripples on water in the lead beautiful, but impossible to cross on foot. Photos by A. Suknev.


Figure 10. Our tracks (red line) and some of the stations made on 28 and 30 March 2016.
Background - Landsat image from 1 April 2016, with black regions - open water and dark regions mixture of ice and open water.

Before going back, we at least made one station with a CTD profile, and with a heavy feeling we went (sometimes at a crawl when the ice was suspicious) back to the Trekol, following our own footsteps with a GPS. Apparently Alexei's feelings were particularly heavy, because on the way back he fell twice in the water through innocent-looking but very thin ice (Figure 11).


Figure 11. Wet Alexei pretends to enjoy sunbathing after going out of one of his man-made swimming pools (right behind). Photo by A. Suknev.
We got back to the Trekol and did some more stations away from the ring, where the ice was stable. However, the second rope, with precious data and the even more precious second hammer, was - so far - out of our reach...

A miracle happened the next day, when the Barguzin National Park agreed to help us with a miraculous device - an inflatable boat with a propeller ("aeroboat", Figure 12). So two days later ( 30 March) we were back in the ring region, with the aeroboat and its driver Nikolay.


Figure 12. We (inside UAZ) and aeroboat (outside) were first transported to the Nizhneye Izgolovye Cape. Then we went to the ice ring with the aeroboat. Photo by A. Suknev.

What we saw from the aeroboat in the ring region will forever stay in our memory. Photos (Figure 13) can not do full justice to the path we took. A mixture of leads, openings, holes, stable ice and again leads and holes, holes and leads...

b)


Figure 13. a) lead (width about $15-20 \mathrm{~m}$ ) on the eastern boundary of the ring, b) leads (3-5 m wide) in the central part of the ring, c) holes and leads near the second rope location. Photos by $A$.

Arriving at the location of the second rope (with leads and holes in the vicinity, see Fig 13c), we realised that there was a fair chance that the ice where the rope was could have already melted sending all the equipment and the second hammer to the lake bottom, at the depth of 1500 m . However, the GPS coordinates were on stable ice. Wonderful! Alexei with the GPS at hand walked in small circles around the indicated point. The rope was not there. Everyone then walked in small and large circles - the rope was still not there. Severe disappointment - apparently ice had moved on and GPS was useless.

We thought that we would never find the rope, until Nikolay took the binoculars (Figure 14) and spotted a small wooden stick that we had left near the rope. We drove there with aeroboat - and the rope was there! 250 m from the initial point (see Figure 10), but it was there! After some drilling we recovered the equipment with data (Figure 15) and - finally - the second hammer!

We continued to do CTD measurements around the ring. Now we have two half-transects across the ring, that show the same anomalous water structure as in February, thus again confirming that ice rings are the surface manifestation of an eddy located below the ice.


Figure 14. Nikolay looking for wooden stick that marks the rope location. Photo by A. Suknev.


Figure 15. The second hammer is recovered! Magic wooden stick is seen on the background. Photo by A. Suknev.


Figure 16. Andrey, Alexei and Andrey on the aeroboat near the Nizhneye Izgolovye Cape. Photo by

## A. Suknev.

On 31 March 2016 we drove back to Ulan-Ude and further on to lake Hovsgol in Mongolia, but that's another story. Thanks a lot to the spirits of Lake Baikal, and to our faithful friends and colleagues who made it all possible!
D. Postscriptum. Further evolution of ice ring.

a)

d)

Figure 17. MODIS satellite images for 3 April (a), 7 April (b), 8 April (c) and 9 April (d).

On 3 April 2016 a huge lead appeared on the south-eastern part of the ring. This is where Andrey and Alexei tried to cross the ring on foot five days earlier. On 7 April the ring was no longer a ring, but a giant hole with drifting ice inside. Looking at images from 8 and 9 April you may have a feeling that the ice ring now starts to look like - wait - Ying and Yang! OK, maybe this is just imagination? But wait a bit...


Figure 18. MODIS image from 10 April 2016 (and also an Ying-Yang symbol for comparison).

The next day's image shows something unbelievable. The ice turned white because of metamorphism on the surface, long cracks extend from the former ring in different directions, making it looks like a giant four-legged spider. But the most interesting thing is now in the region of the ice ring itself: the Ying-Yang symbol is fully complete with the white dot (ice floe) in the black part (open water) and the black dot (a small lead) in the white part (compacted broken ice). No Photoshop, just nature at work seen by a satellite!

## E. Thank you!

Many thanks to those who participated directly or helped to organise field surveys! Members of 2016 winter expeditions: Alexei Kouraev (Toulouse), Andrey Suknev (Ulan-Ude), Roman Zdorovennov (Petrozavodsk), Andrey Laletin (Krasnoyarsk), Alexander Beketov, Mikhail Fomenko and Nikolay Makoveev (Ust-Barguzin). MODIS images are from Irkutsk RICC website (http://geol.irk.ru/bricc.htm), Landsat data are available from the U.S. Geological Survey. Many thanks for Nick Hall (Toulouse) for improving the text. Photos are by A. Suknev, A. Kouraev and N. Makoveev.

## F. Publications:

Giant ice rings on lakes and field observations of lens-like eddies in the Middle Baikal (2016-2017). Alexei V. Kouraev, Elena A. Zakharova, Frederique Remy, Andrey G. Kostianoy, Mikhail N. Shimaraev, Nicholas M. J. Hall, Roman E. Zdorovennov, Andrey Ya Suknev. Limnology and Oceanography, 2019, doi: 10.1002/lno.11338", open access at https://aslopubs.onlinelibrary.wiley.com/doi/epdf/10.1002/lno.11338 as well as on our web site http://www.icerings.org/LO19_Kouraev.pdf.

Giant ice rings on Lakes Baikal and Hovsgol: inventory, associated water structure and potential formation mechanism, Kouraev A.V., Zakharova E.A., Remy F., Kostianoy A.G., Shimaraev M.N., Hall N.M.J., Suknev A.Ya., Limnology and Oceanography 61, 2016, p. 1001-1014, doi: 10.1002/lno.10268, open access at http://onlinelibrary.wiley.com/doi/10.1002/lno.10268/pdf as well as on our web site http://www.icerings.org/LO16_Kouraev_EN.pdf.

