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SCIENTIFIC RESEARCH REPORT

*Magnetic survey around Chaa-Hole village, The Tyva Republic,
Russian Federation*

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ANNOTATION

The whole report contains 17 pages and 8 pictures.

TYVA REPUBLIC, SAYANO-SHUSHENSKAYA DAM, BURIAL SITE, MAGNETIC SURVEY, STONE BOX, STONE PLATE.

The object of research is the Hunnish burial site, situated in the coast zone of the Sayano-Shushenskaya Dam.

The search target was to determine borders and structure of burial site by finding in situ graves (stone boxes), using natural scientific distance methods (magnetic survey). Before applied classical research methods are presented with destroyed stone boxes, human remains and different artifacts.

Common investigated site surface worked out 1 hectare. Unfortunately, due to natural reasons (insufficient contrast of magnetic properties of the sought objects and their environment; heavy wind on sand surface; systematic obstacles for humans and equipment), on the investigated territory we didn't discover any in situ stone grave.

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INTRODUCTION

This report presents the results of field research works in April and May 2011, carried out in the Sayano-Shushenskaya Dam coast. The total investigated area composed 1 hectare.

The main target of this work was to provide magnetic survey carrying, to determine the borders of the sought burial site and in situ stone graves.

During the previous field works were found the concentrations of stone plates — fragments of stoned burial boxes constructions, and some individual findings. Effecting field magnetic survey in 2011, we investigated the coast sand line of dam, directly those places with stone plates concentrations and the area neighbored by.

LEADING RESEARCH

The search area, according to materials and its description, represented itself the steppe zone with sand bed without ground or humus. In the beginning of our research the magnetic properties of sand were unknown. As far as the sand was essentially dislodged, was made an assumption about its magnetic homogeneity. The sand bed is periodically exposed due to water, which demolish the natural dam borders and their poor grass covering. But the exposed sand is formed, on the border of inundable and steppe zone by hard steppe winds, in coast dunes. (pic.1).

Our introduced method of magnetic survey is based on the magnetic properties difference of the sought archaeological objects and environment. We measure the earth's magnetic field near the burial site surface with a short step.

Therefore, in the homogeneous paramagnetic ambience we can determine the nonmagnetic filling anomalies: nonmagnetic stones with sufficient size, air bubbles in the stone boxes. And vice versa, in the nonmagnetic and paramagnetic material we can detect anomalies from magnetic objects. These are the plates of stone boxes, which contain magnetic minerals with ferromagnetic properties, iron-containing grave goods, elements of clothes, massive jewels with iron composition; also drift of magnetically charged upper soil levels in lacunes, cavities and holes; big volumes of decomposed organic material (for instance, kitchen midden).

All these findings gave us the assumption, that stone boxes have the magnetic contrast around their fillings. On behalf on this maintenance we've decided to choose magnetic survey method.

To our regret we do not have the concrete data about the depth occurrence of in situ stone boxes. The magnetic research implementation was hardly complicated by the dunes on the surface: variation with altitude compiled several meters between dunes and the average altitude of the region, that's why the bigger was the distance till the object, the less magnetic anomalies we detected.

Initially we investigated the concentration of stone plates — fragments of the earlier found stone boxes. The box represent itself rectangular construction out of 5 centimeter width stone plates. The plates were removed from the places with the foliated rock outburst. The sought and not dislodged boxes should contain air bubbles, which allows them to discover.

The clear anomaly from plates concentration or separate plates we didn't fix — we registered the superposition of anomalies. A number of plates were paramagnetic and had +1 — +10 nT anomaly. Another plates were nonmagnetic, they didn't reveal any ferromagnetic properties and didn't change the magnetic field.

Magnetic survey methods

Field magnetic survey was carried out with the help of two magnetometers — optically pumped magnetometer PKM-1 ("Geologorazvedka" production, Saint Petersburg, Russia) and proton gradiometer in magnetometer regime MMPG-1 ("Geologorazvedka" production, Saint Petersburg, Russia).

During the field work MMPG-1 detector worked as base station and controlled the earth's magnetic field changes. We installed this detector static on the special chosen platform with a small magnetic field gradient. Every 15 seconds were fixed the measurements of geomagnetic field variations.

The magnetic survey of the sites was realized by PKM-1 magnetometer. Previously on every site we created rectangular coordinate grid. Along two opposite sides (horizontal borders of site on the received maps) were stretched nonmagnetic tape measures. Vertical to it (parallel to vertical axis on the map) after every 2 meters we stretched measured cord with 1 meter marks. Thus, researched sites were covered with measurement grid after every 0,5 meter. The measurements were held on the 0,3 meter above the surface.

On 27 of april 2011 we started the research field work. In the dam coast line, where we examined the concentration of graves and artifacts, we held reconnaissance magnetic survey. These graves were partially preserved. The common square contained 2 rectangularly shaped sites with the next size 25×55 m and 20×55 m (pic. 2).

The surface of the site we started to explore didn't have any decisive inequality. All the anomalous objects, except for stone box fragments, were hidden under ground. There was no water around, because dam fills out normally during the summer time.

On the magnetic map (pic.2) is registered superposition of anomalies in the place with plates concentration (coordinate 20;95—100). At the same time, on the other sites maps we can see anomalies with the same amplitude, but more wide. There are positive anomalies (dark color on the magnetic map) and negative (light color). So, some stone boxes or their fragments, which are lying near the surface, we can localize according to the sharp superpositions of positive anomalies.

On our magnetic map you can see stripes, maybe parallel coast lines, formed by billow waves. Also we caught 2 wide negative anomalies with coordinates (20;100) in the first site and (16;54) in the second one. In the first site anomaly from three sides is surrounded by the narrow positive anomalies — concentration of stone boxes plates. The second anomaly didn't have any

positive tales. These two anomalies can have the anthropogenic character. We also tried to find stone plates of the boxes with the sounding borer, but in vain.

We made trial magnetic survey of demolished part of dam coast line and on 29 of april 2011 we repeated our survey of undamaged coast. We made a rectangular site with dimensions 50×60 m (3000 m per sq). One of its sides bordered to cliff, which was situated above the site we explored a day before (pic 1).

From the left of the magnetic map (pic.4) we fix wide negative anomaly with rectangular end. As for relief, in that place we see an embedment about 1,5 m, which coincide with our negative anomaly. Apparently, wide positive anomalies, which ring negative anomaly, are the result of ground and sand applications. From the right of the magnetic map relief is flat, without frank high surface differences.

First and last, in the investigated site we didn't fix any sharp local negative anomalies, which differs from the natural environment anomalies. We tried to check some positive anomalies with sounding borer, but didn't find sought stone boxes.

Magnetic survey of the sand dune partially confirmed our version, that sand applications reduce and block positive anomalies, radiated from the sought objects. To reduce the dunes impact on our magnetic search, on 1 of May 2011 we made a magnetic survey of a site, which was closed to dunes from steppe side (eastern part).

The divided site had a square form (pic. 5) and 50×50 m size (2500 m per sq). It was a part of flat steppe surface without altitude differential. During the magnetic survey we tried to reveal the natural position of earth's magnetic field, without sand and ground application influence. In upper part of magnetic map we marked the contour of the dune.

In upper left part of magnetic map you can see positive anomaly, created by the dune end. In such a way, we confirmed our assumption, that sand dunes give positive anomalies.

On the site from steppe side we revealed the wide positive anomalies. Their size is smaller then size of anomalies on the coast line and dunes sites. On the steppe site such kind of anomalies can have alluvial or anthropogenic character (for instance, remains of sites or corrals).

After we finished magnetic survey on the main part, we investigated the box fragments — concentration of known stone plates. For that, over the concentration we marked a site 4,5×18 m size. On the magnetic map we fixed superposition of positive and negative anomalies (pic.3).

The results on the magnetic map didn't give us the clear image: where we see stone plates anomalies and where the anomalies have the natural environment character. In the center

of the map we fix two dipoles, directed to each other with positive poles. That anomalies were formed by collapse of the stone plates. Right side from these anomalies along maps edge we can see the long positive anomaly, which doesn't have the stone plates character.

In the previous expeditions earlier on this place were held pilot excavations. That excavations didn't fix in that place any stone plates concentrations.

On 2nd of May 2011 we made micromagnetic survey experiment, using concentration of the stone plates. That for we've chosen a site 7,5×12,5 m size (the same altitude, but in every 0,25 m). Our experiment we divided in 2 stages: at first, we made magnetic survey of the flat surface without stone plates (pic.6). At second, we made magnetic survey of the same surface with artificial stone plates concentration. (pic.7).

Our experimental goal was to discover in detail stone plates concentration anomalies. Finally, stone plates created negative anomaly -75 nT (pic.7). The anomaly magnitude is equitable with the magnitude of environment. The form and contrast also do not have the differences.

As a result of our micromagnetic survey experiment, we didn't find distinctive characteristics of the stone boxes.

On 5 of May 2011 we made a survey of the site 28×56 m size (1568 m per sq) by the cliff edge. On the magnetic map the edge cliff coincide with left (western) edge of the map (pic.8). We fixed the wide positive horizontal anomalies of the eroded sand level. The revealed anomalies are liked anomalies from the cliff edge we discovered on 29 th of April 2011.

This site is situated above the sand coast, where we found another stone plates concentration. Here we didn't manage to find effective magnetic anomalies we could determine the disposition of the stone graves.

CONCLUSION

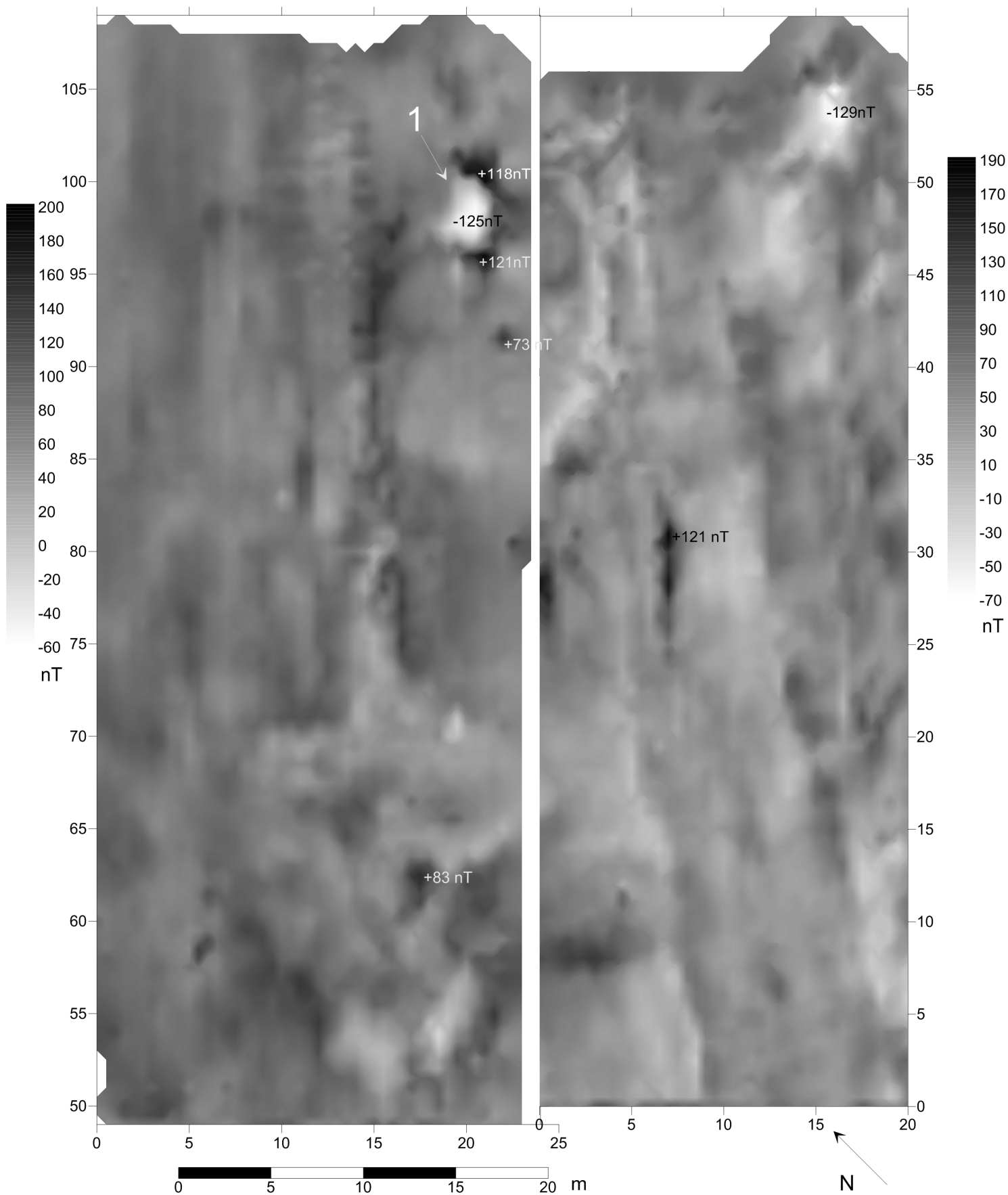
In the course of the magnetic survey of the Hunnish burial site situated in the coast zone of the Sayano-Shushenskaya Dam we explored 7 sites with total surface 1 hectare.

Unfortunately, due to natural reasons (insufficient contrast of magnetic properties of the sought objects and their environment; heavy wind on sand surface; systematic obstacles for humans and equipment), on the investigated territory we didn't discover any in situ stone grave.

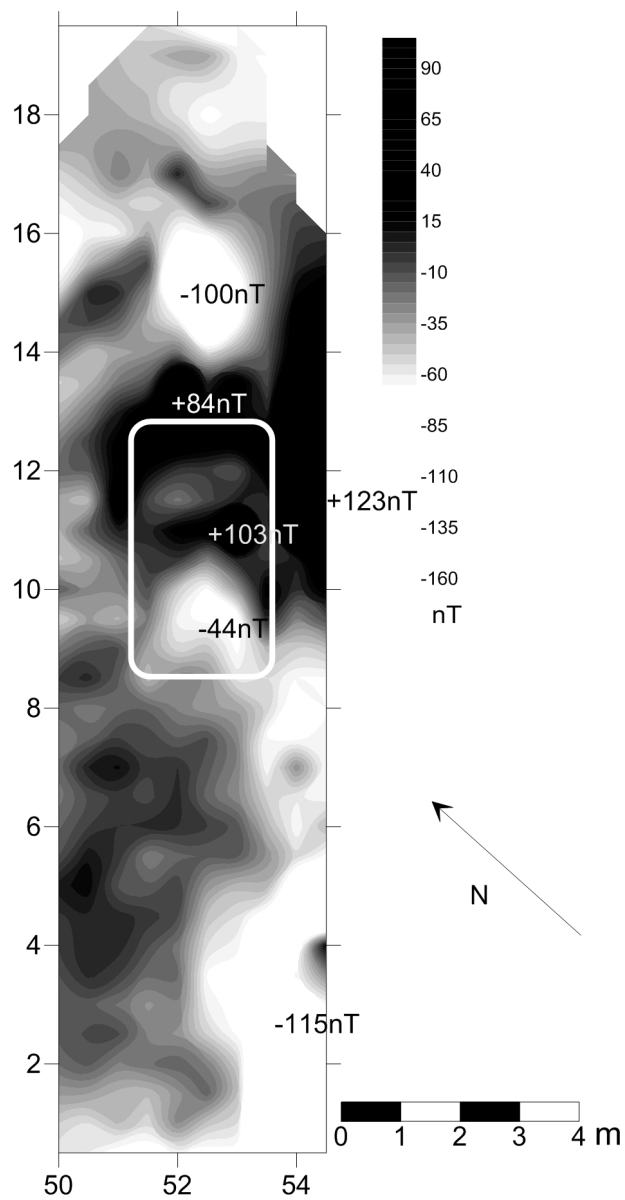
In the Yenisey hollow, flooded by the Sayano-Shushenskaya Dam, underlie earth materials, which contain rare minerals. Probably, the received, as a result of our field work, positive anomalies could be the consequence of ferruginous earth materials concentrations. To check that hypothesis we have to explore the samples from anomalies, using electron spin resonance (ESR) and other methods of spectral analysis.



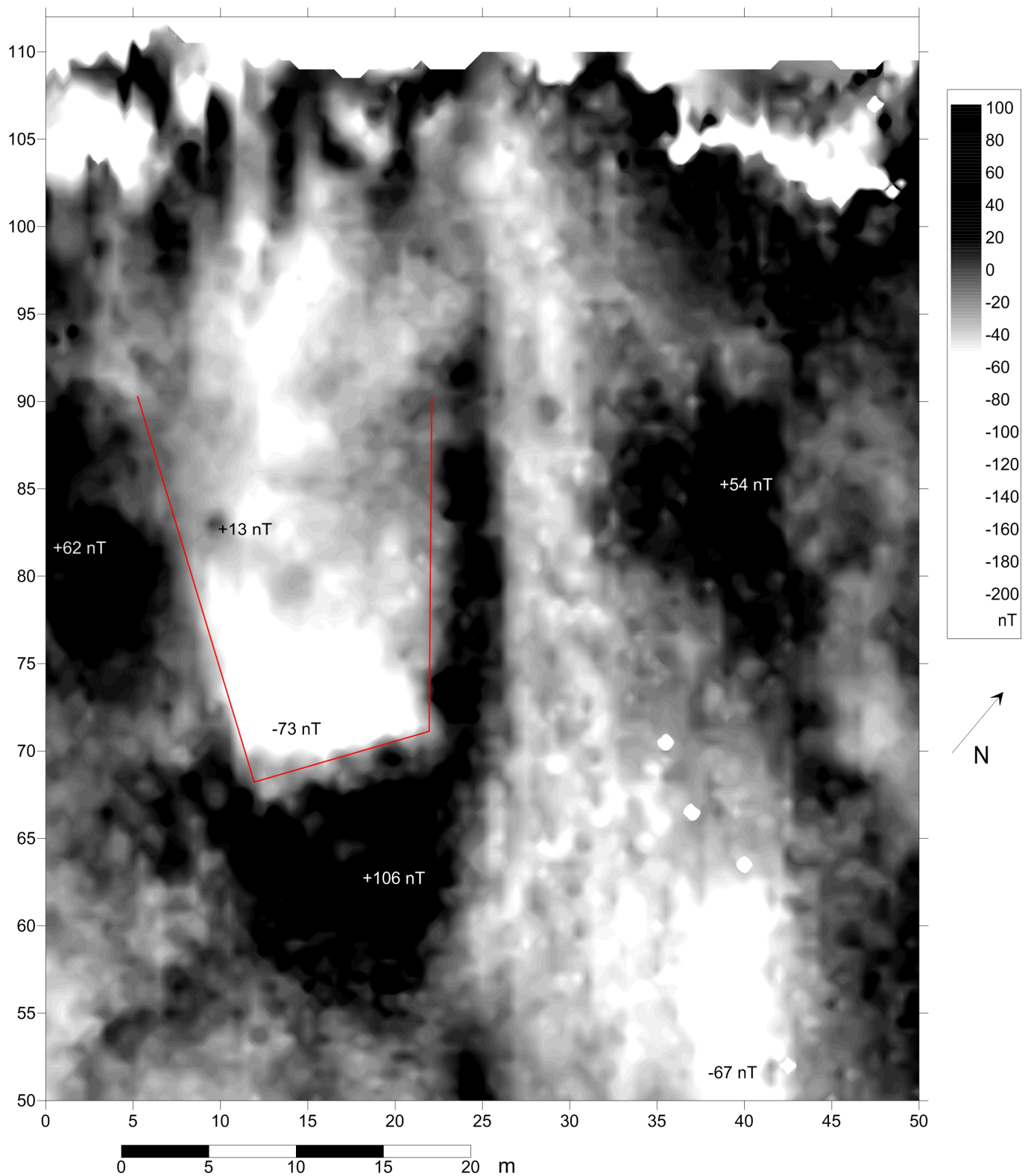
Pic. 1. Plan of investigated area of Hunnish burial site in the coast zone of Sayano-Shuchenskaya Dam close to Chaa-Hole village. Space photo from Google Maps resource. Situation of magnetic survey sites.
 1 - site measured 27.04.2011
 2 - magnetic map 29.04.2011
 3 - magnetic survey site 01.05.2011
 4 - survey 05.05.2011



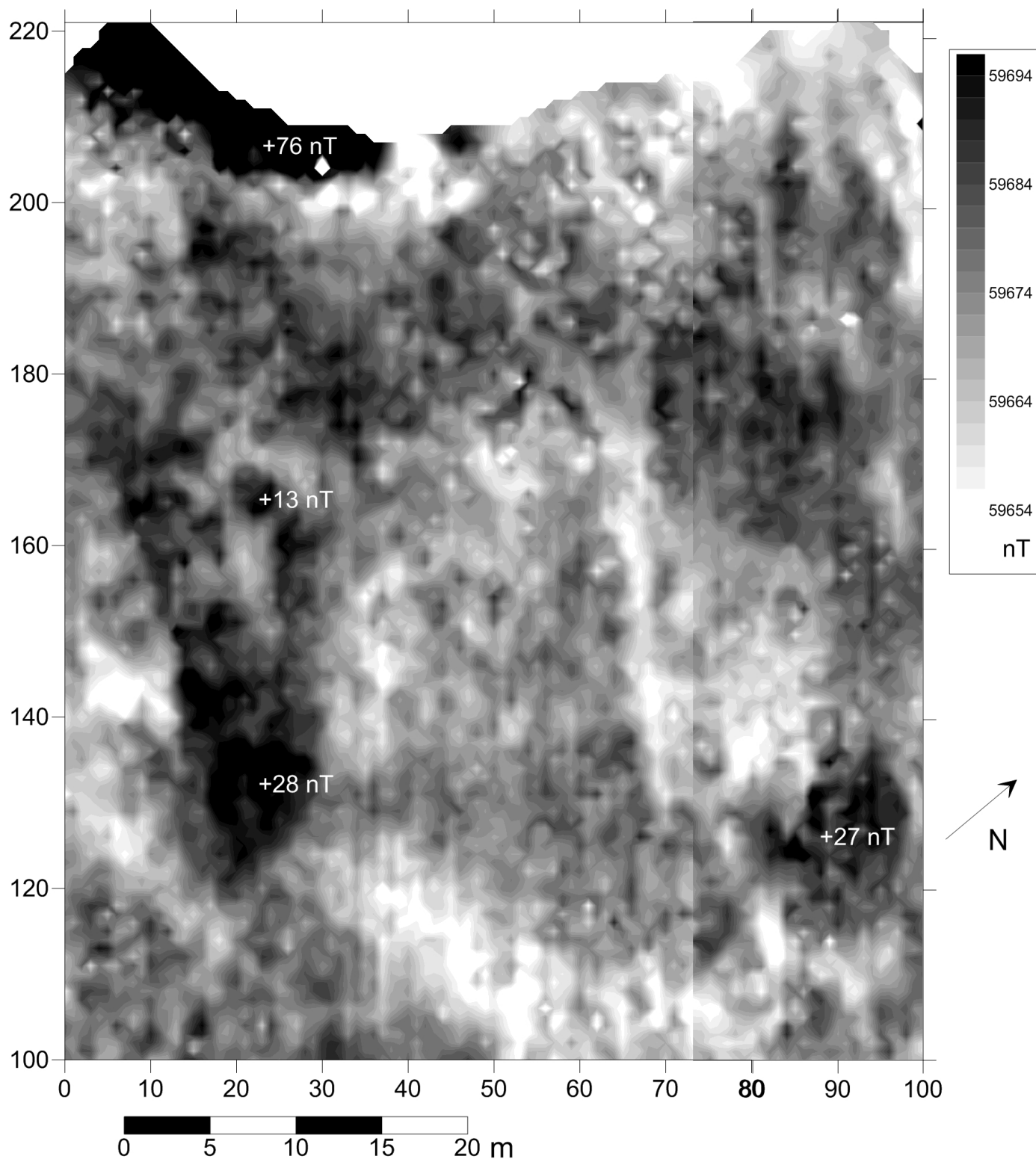
Pic. 2. Magnetic map of site on coast line. Coast of Sayano-Shushenskaya Dam close to Chaa-Hol village. Isolines step 2 nT. Positive anomalies are showed in dark colours, negative - in light color. Cluster of stones is marked "1". Survey 27.04.2011. Andrei Chudin.



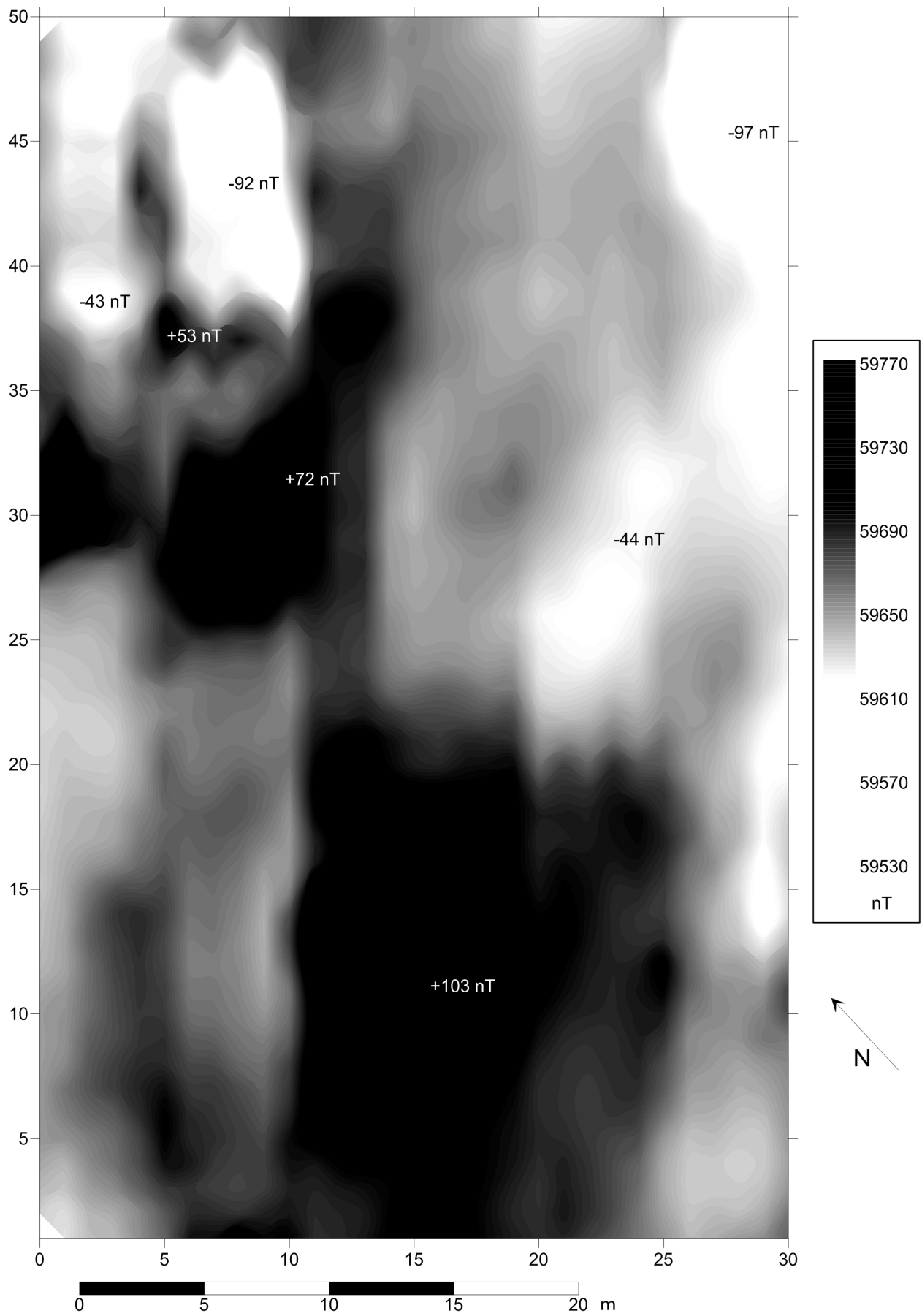
Pic. 3. Magnetic map of site on the coast line of Sayano-Shushenskaya Dam close to Chaa-Hole village. Cluster of stones, simulating grave stone box. Isolines step 2 nT. Cluster is marked with white contour. Survey 27.04.2011. Andrei Chudin.



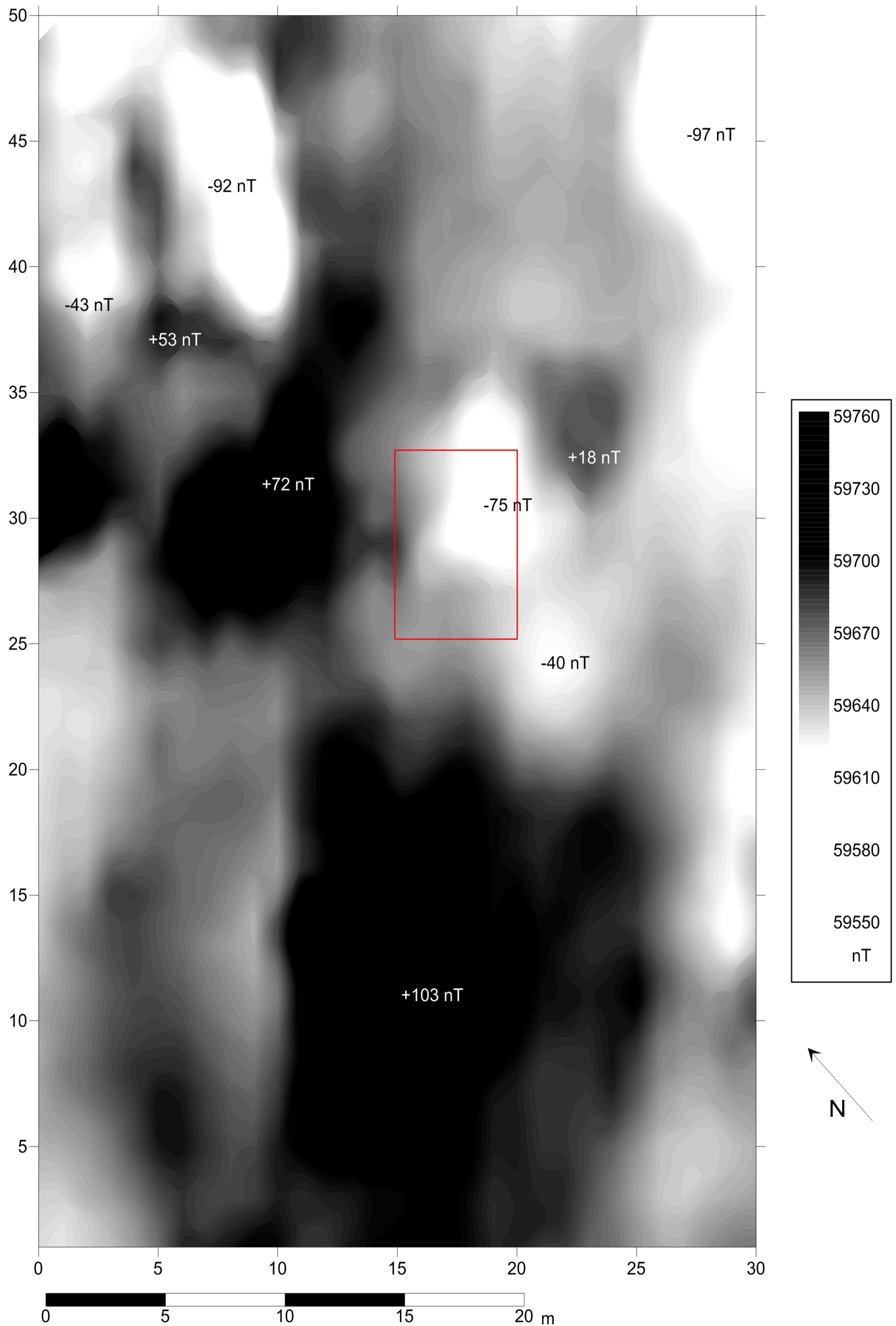
Pic. 4. Magnetic map of site with dunes. Coast of Sayano-Shushenskaya Dam close to Chaa-Hol village. Isolines step 2 nT. Top side of map is border to cliff. Embedment in relief is contoured with red line. Survey 29.04.2011. Andrei Chudin.



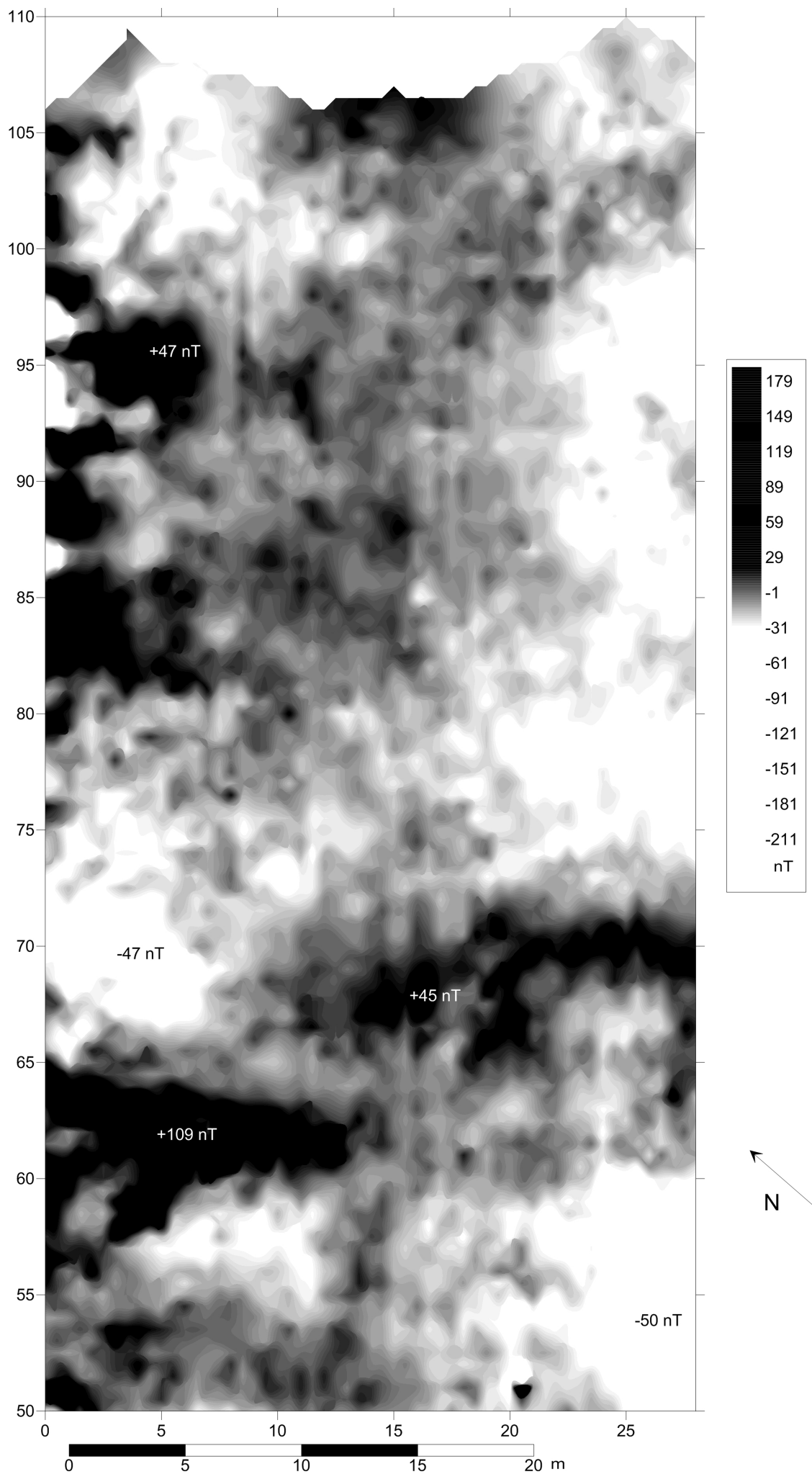
Pic. 5. Magnetic map of the site with steppe surface close to dunes. Isolines step 2 nT. Top side of the map is border to sand dune. Survey 01.05.2011. Andrei Chudin.



Pic. 6. Magnetic map of the site on coast line. Micromagnetic survey of empty site before grave stone box simulation. Measurement step 0,25 m. Isolines step 2 nT. Survey 02.05.2011. Andrei Chudin.



Pic. 7. Magnetic map of site with collection of stones, simulating grave stone box. Micromagnetic survey. Measurement step 0,25 m. Isolines step 2 nT. Cluster of stones is marked with red rectangle. Survey 02.05.2011. Andrei Chudin.



Pic. 8. Magnetic map of site with sand dunes. Coast of Sayanp-Shushenskaya Dam close to Chaa-Hol village. Isolines step 2 nT. Left side of the map is cliff border. Survey 05.05.2011. Andrei Chudin.