



LARGEST MAN-CAUSED SEISMIC PROCESSES IN THE WORLD. BACHATSKOE EARTHQUAKE, JUNE 18, 2013 (ML = 6.1, KUZBASS)

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It is considered seismic activity in area of one of the largest coal quarries of Kuzbas "Bachatskij", which in 2012-2013 thrice was accompanied by a strong earthquake with a magnitude of more than 3.5.

June 18, 2013 at 23:02 UTC (June 19 at 06:02 local time) earthquake with magnitude ML = 6.1 (mb = 5.5) occurred in Kuzbas. Its epicenter (54.29°N, 86.17°E, depth of 4 km) was on the Bachatskij quarry edge. Following the title of quarry earthquake was named Bachatskoe. Bachatskoe earthquake is the largest man-caused earthquake in the history of the Earth at the moment.

Macroseismic investigation conducted in the epicentral area by ASB GS SB RAS showed that the earthquake was felt on the vast territory. Shakability reached by seven points in the village nearest to the epicentre. There were destructions of buildings. Some cities of Kuzbass (Leninsk-Kuznetsky, Polysaev and others) were included in a five-points-zone. The earthquake was felt outside the Kemerovo region (Novosibirsk - 4 points, Kemerovo - 3 points, Taiga - 2 points) also.

It was investigated on the existence of induced seismicity in the area of the Buchatskij quarry till year and a half to Bachatskoe earthquake. The basis for this investigations was the seismic event with ML = 4.3 occurred on February 9, 2012 at 13:24 UTC (20:24 local time) with the coordinates of the epicenter (54.28°N, 86.15° E) positioned on the quarry edge. This event has also caused noticeable vibrations in most of the cities of Kemerovo region and has caused a great public resonance and an investigation of authorities and the staff of the Ministry on the subject of the explosive nature of this event. About 120 seismic events were registered by 25 temporal seismic stations during the period on March 2 to May 14, 2012 in the area of the coal quarry, one third of which, according to acts of the blast, was not industrial explosions. On the basis of coincidence of seismic events with active area of quarrying and their distribution depending on the time of day was set man-caused character of the studied events.

Besides marked by a strong event appreciable earthquakes were occurred in 2012-2013 in the area of Bachatskij quarry, the largest of which was May 4, 2013 at 17:30 (UTC) with magnitude ML = 3.9.

Thus, seismic activation permanently registered in the area of the quarry in the form of continuously flowing seismic process with the events of small energies and powerful short activations, the strongest of which was Bachatskoe earthquake in 2013.

Temporary network of ten seismic stations installed on the first day after the main shock of Bachatskoe earthquake in the vicinity of the quarry was allowed to register a powerful aftershock process. Hypocenters of 956 earthquakes in the range of magnitudes $0 \leq ML \leq 4.2$ were registered during period from June 19 to October 8, 2013.

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30-70 earthquakes per day occurred in the first days after the main shock and units per day occurred later month and a half. However, aftershock process at the level of moderate earthquakes continues. So up to several noticeable events in the month with a magnitude of more than two were registered by the regional seismic network in the Altai-Sayan region for the period October - December 2013. One of the strongest earthquake occurred on October 21, 2013 at 17:24 UTC with $ML = 3.2$.

Epicenters of Bachatskoe earthquake aftershocks is presented on Fig. 1. Aftershocks are distributed within the quarry but also single small events are out of it. At the same time shallow earthquakes mainly localized in the central part of the quarry while the largest - around the sides. At the southern edge of the cut cloud epicenters forks, moving beyond excavation (Fig. 1).

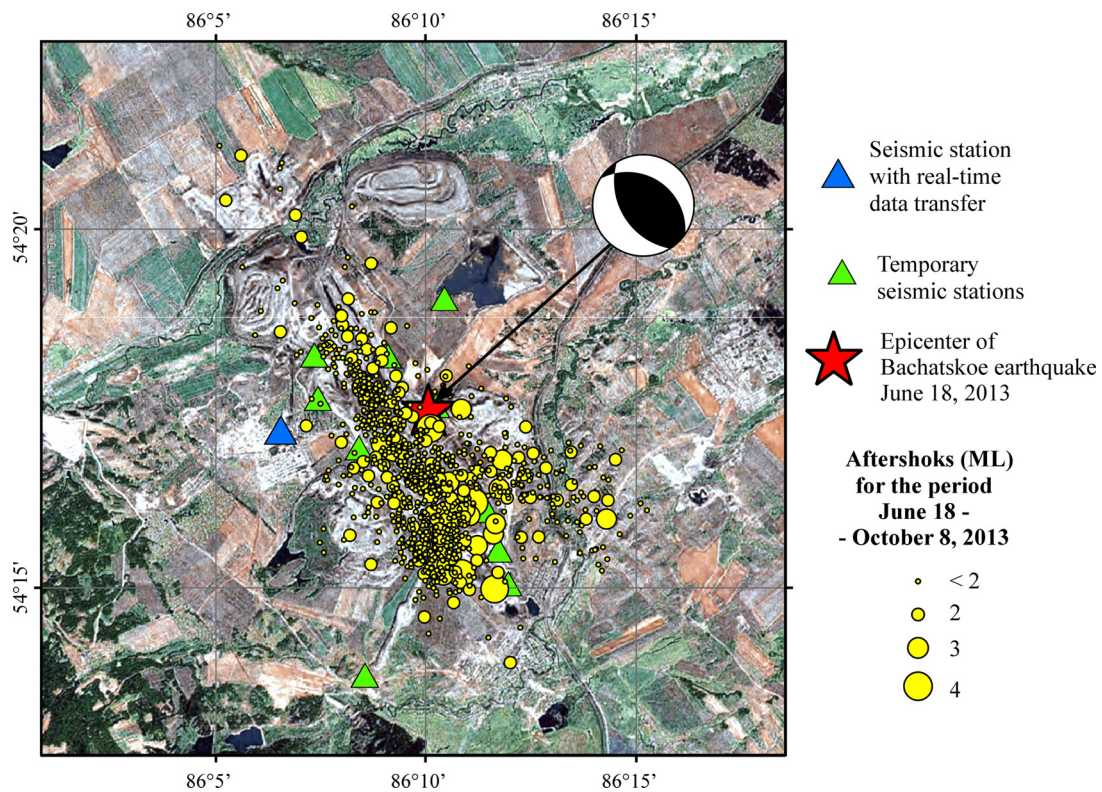


Figure 1. Epicenters of Bachatskoe earthquake aftershocks for period June 18 – October 8, 2013

Focal mechanism of the Bachatskoe earthquake represents almost pure thrust (Fig. 1). Nodal planes, one of which is a plane of rupture, are located along a strike of the cut, which may be evidence of a man-caused nature of this earthquake.

Thus, due to the powerful man-caused influence on the earth crust in the area of a Bachatskij quarry a weakened area is created, in which initiated the process of induced seismicity. Earlier our experiments with temporary networks of stations in Kuzbas induced seismicity was found in the area of mines producing coal (Emanov et al., 2012; Oparin et al., 2013). In this case we recorded seismic activity in the area of open quarry. This seismic activity is accompanied by a strong earthquake including the strongest man-caused earthquake in the history of the Earth – Bachatskoe (June 18, 2013, $ML = 6.1$).

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