

# Sinkholes above Abandoned Coal Field in Iwaki City Hit by the April 11<sup>th</sup>, 2011 Hamadori Earthquake

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## Key Facts

- Hazard Type: Sinkholes
- Date of the disaster: Mainly April 11<sup>th</sup>, 2011 Hamadori Earthquake of  $M_{JMA}$  7.0 ( $M_W$  6.4)
- Location of the survey (Lat. Lon., name or address): The entire extent of Idosawa and Yunotake Faults
- Date of the field survey (if any): March 27<sup>th</sup>, 2012
- Survey tools (if any): GPS
- Key findings: kml file for locations of sinkholes

**Key Words :** sinkholes, abandoned mines, April 11<sup>th</sup> 2011 Hamadori Earthquake, seismic faults

## 1. INTRODUCTION

Iwaki City had developed into an industrial city for the exploitation of Joban coalfield. Being located about 100 to 200 km north of Tokyo, the Joban coalfield had long been the largest in Honshu until the coal industry, which had provided underlying support for post-World-War-II reconstruction in Japan, experienced the energy revolution in the 1960's. The last surviving coal mine "Joban" closed in 1975. Therefore there reportedly remain 214 pits and tunnels having the combined length of 499km in total over the entire 100km long stretch along the Pacific coastal area from Tomioka (about 10km south of the Fukushima Daiichi NPP) to Hitachi, Ibaragi Prefecture.

Though sinkholes above abandoned shallow coal mine tunnels had been regularly reported in this coalfield area, the number of reports in Iwaki City of sinkholes, which are suspected to be due to collapses of shallow tunnels, suddenly increased after the March 11<sup>th</sup> 2011 Earthquake and more remarkably after the April 11<sup>th</sup> Earthquake. This Factsheet summarizes the result of the author's interview and field surveys in Iwaki City on March 27<sup>th</sup> 2012.

## 2. REPORTED SINKHOLE EVENTS

Fig. 1 shows the timeline for the sinkhole reports at Iwaki City. As has been mentioned, the number of reports showed a sudden increase after the March 11<sup>th</sup>, 2011 Off the Pacific Coast of Tohoku Earthquake<sup>1</sup>) and more remarkably after the April 11<sup>th</sup> Hamadori Earthquake<sup>2</sup>).

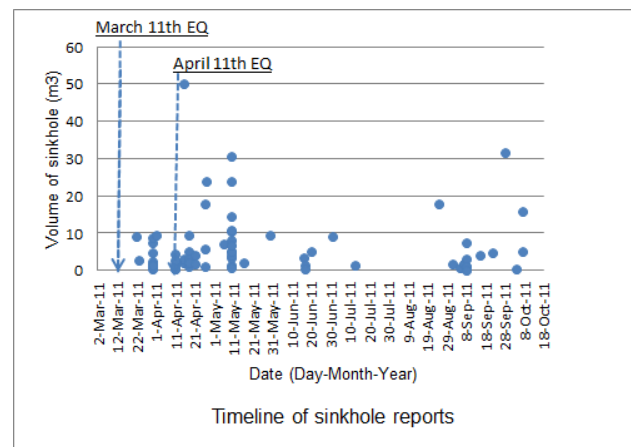


Fig. 1 Timeline of sinkhole reports (Iwaki City<sup>2</sup>)

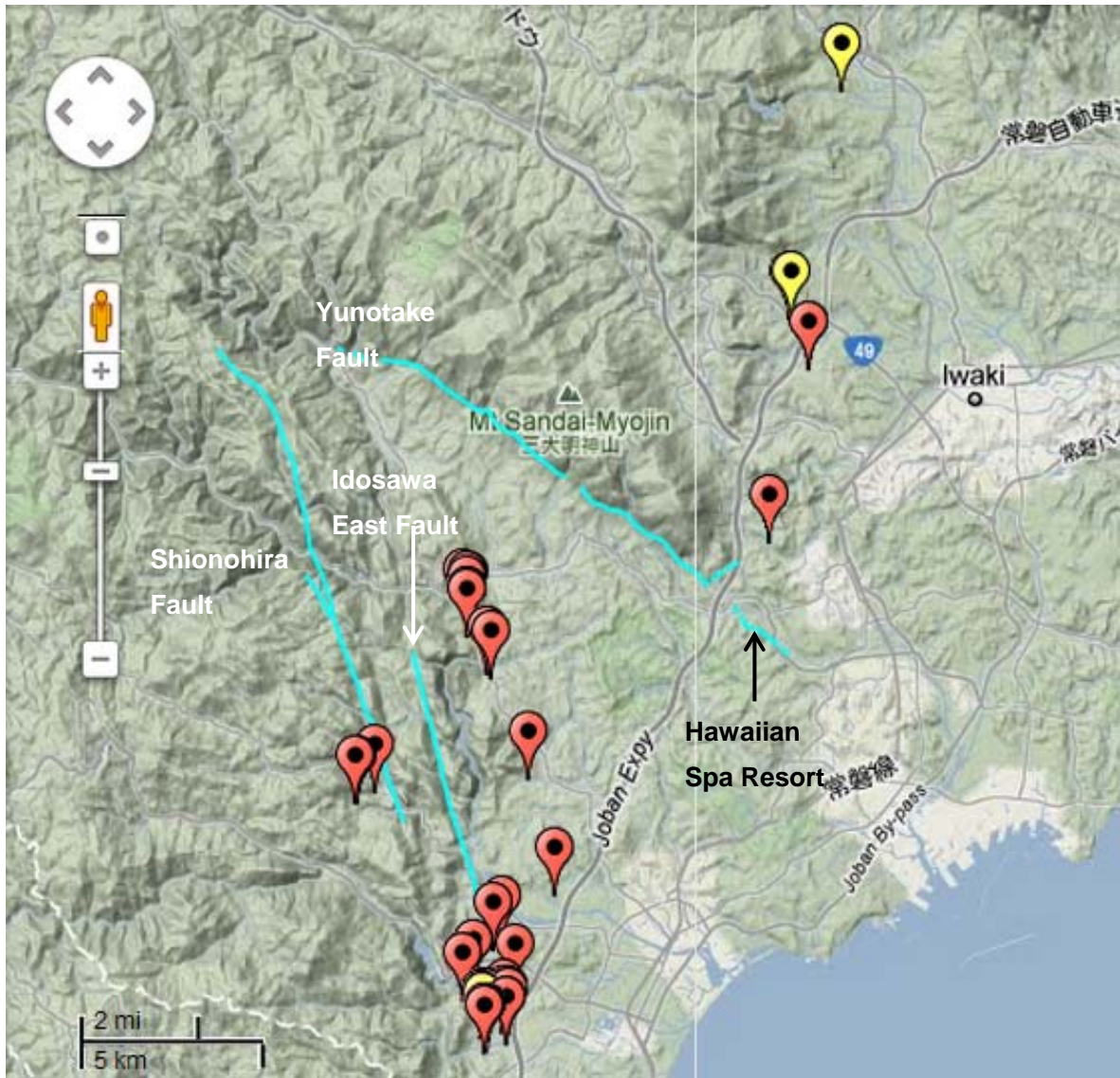


Fig. 2 Locations of reported sinkholes after March 11<sup>th</sup> EQ (Iwaki City)



Fig. 3 Sinkhole (3m × 7m × 1.5m deep) at Tabito plugged up (Photo by Kazuo Konagai at 36.951532, 140.700233 on March 27<sup>th</sup>, 2012).

The locations of reported sinkholes are shown in Fig. 2. Yellow and red place marks are those reported from March 11<sup>th</sup> to April 10<sup>th</sup> (before the April 11<sup>th</sup> Earthquake) and after the March 11<sup>th</sup> Earthquake, respec-

tively. It is noted that red place marks make up some clusters in Tono, Tabito and Nakoso areas, all near the fault rupture traces that appeared in the April 11<sup>th</sup> Earthquake.



Fig. 4 Sinkhole (2m × 5m × 5m deep) at Tono plugged up (Photo by Kazuo Konagai at 36.994963, 140.729808 on March 27<sup>th</sup>, 2012).

These sinkholes have been quickly and securely plugged up with soils as shown in Figs. 2 and 3. But sinkholes are still being reported occasionally. Even at some of the holes plugged up, continual saggings are often found being developed (Fig. 4).

#### 4. SUMMARY

The Mw9.0 Off the Pacific Coast of Tohoku Earthquake was followed by several moderate to large aftershocks occurred at crustal depths of about 12 km in southeastern Fukushima Prefecture. Among them, the April 11<sup>th</sup> Hamadori Earthquake of  $M_w$ 6.4 was remarkable producing west-down normal surface ruptures.

One of the most noteworthy aspects of the earthquake was that it hit one of the Japanese largest coal field, which was closed in 1976. Since there are 214 abandoned pits and tunnels having the combined length of 499km in total over the entire 100km long stretch along the Pacific coastal area, the current situations contain the potential hazard for continuing sinkhole problems. We need to keep an observant eye on

#### ACKNOWLEDGMENT:

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